

August 1993/\$3.00

# Mobile Radio Technology™

The journal of mobile communications technology



GPS vehicle location, p. 10

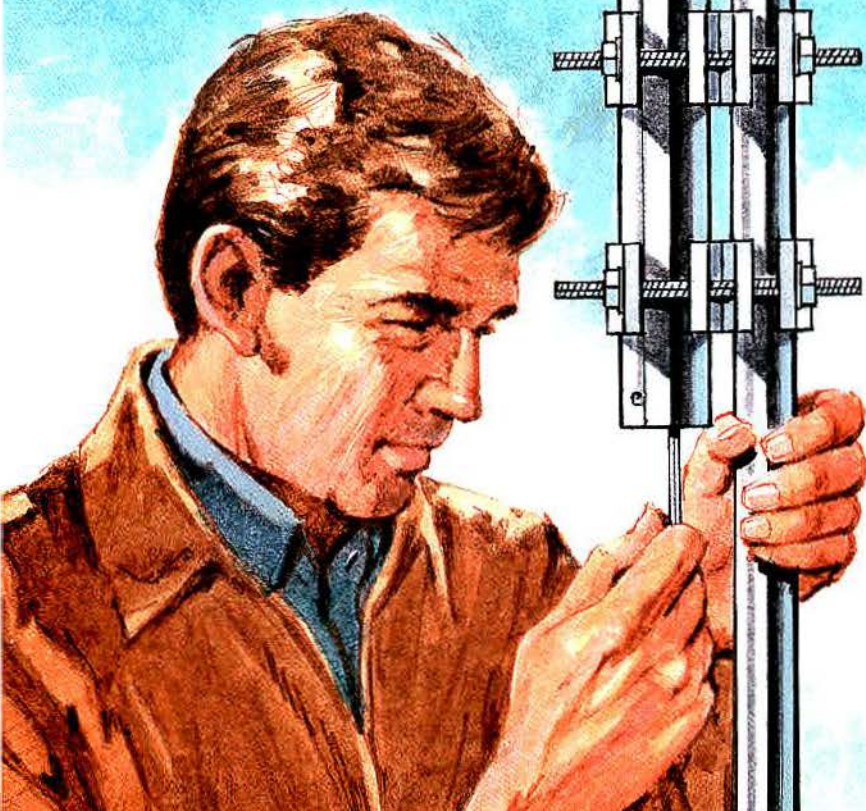
Portable radios  
APCO preview/guide  
Field-tuning isolators  
Troubleshooting methods

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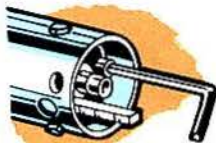
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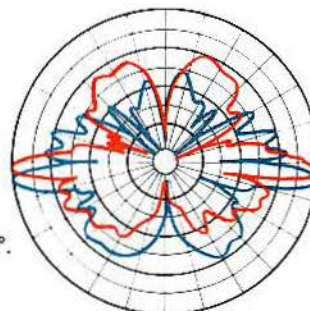
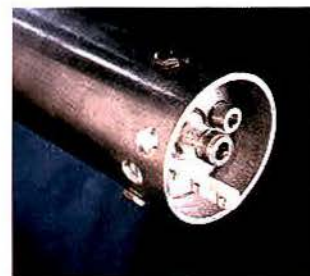
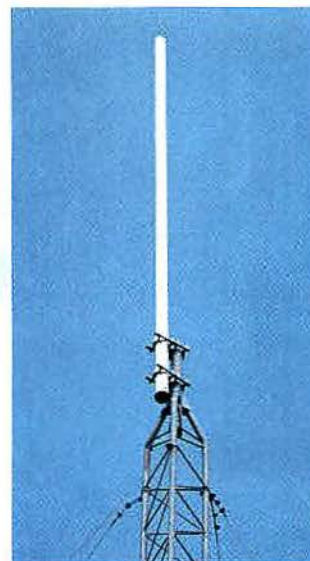
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*Roald Steen*

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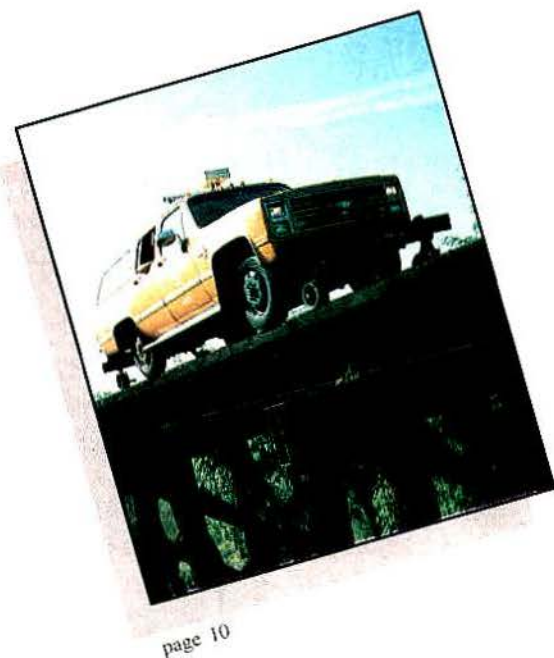
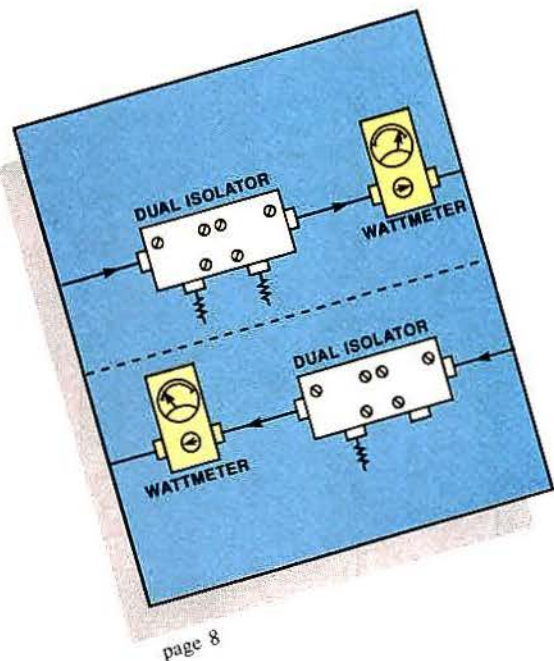
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**On the cover:** The city of Hartford, CT, communications center maintains dispatch operations for all police, fire and emergency medical service functions in the city. Photo courtesy of Ericsson GE.

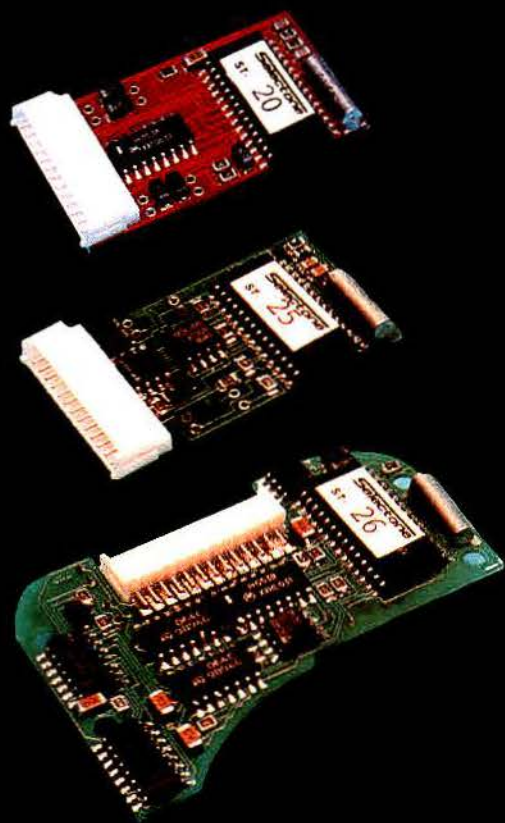
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## Location information adds value to radio communications systems



*Where are you?  
Where have you been?  
Where are you going?*

Technology that uses radio waves passing through the air to carry information is fading into the background.

When people use mobile two-way radios with microphones and speakers or portable two-way radios with push-to-talk buttons, they probably know they are using *radio*.

When they use cellular telephones, which do not look like two-way radios, there is less awareness of the radio component. When they use mobile data terminals and portable computers, and maybe pagers, any awareness of the radio component may virtually disappear.

(In fact, the *word* radio is disappearing, too, and is being replaced by *wireless*, leaving it even more up to people's imaginations as to what carries the information—not that it should be important to them.)

All of these marvelous mobile and portable communications devices rely on radio to function, but they rely on their user *benefits* to sell.

### Technology benefit

One particular benefit that adds value to two-way radio is location and navigation information available through the Global Positioning System (GPS).

GPS tells you where you are. Se-

quential position information tells where you have been. A dispatcher may decide where you are going, based on where you are now (and maybe where you've been).

The highly accurate position information offered by GPS equipment helps to boost safety, protect property and save money.

The U.S. Department of Defense (DOD) is spending \$12 billion on GPS, which includes 24 earth-orbiting satellites that send precise time and position information. The information allows receivers to calculate positions on and near the earth.

The DOD uses the system for navigation and weapons targeting and some other reasons we won't even try to guess. But what's important to the industries we serve is that civilians can use GPS, too.

The idea is that the DOD reserves the most highly accurate position information for its own use by encrypting part of the satellites' signals. Whether certain reception techniques get around that, we don't know for sure.

For example, *differential* GPS compares information from receivers at fixed, known locations with information from mobile receivers to improve the accuracy of the mobile receivers' position information. How much more accurate and useful the military's most accurate information would be is uncertain, but the difference may not be important for most civilian applications.

### Benefits

Ship operators benefit because accurate position information helps captains to navigate vessels safely around obstructions and more directly to destinations to save fuel and labor costs.

Aircraft operators gain some of the same benefits because GPS receivers can calculate altitude, too.

Motor carriers can use the position information to route trucks more efficiently and ensure the just-in-time delivery of goods that many manufacturers require.

Hand-held GPS receivers selling for as little as \$600 can be used by hikers

to display their position, reducing the possibility of becoming lost almost to zero.

Dispatching the nearest rescue vehicle to the scene of an emergency becomes easier when the current positions of vehicles in a fleet are known accurately.

Many years ago, we first heard of the idea of parents' putting bracelets on their children that could broadcast their position. The idea was to be able to find the children quickly in case of abduction, but the application could have other uses, too. We don't know of any manufacturer currently offering such a bracelet using GPS and a radio transmitter, but the time may come.

Law enforcement agencies have a great need for positioning information for reasons ranging from safety to dispatching efficiency to documentation. The answer to "Who was where and when?" can be important in resolving legal disputes. Recorded images from video cameras mounted on police cars have helped to resolve some of these questions, and recordings of position information from GPS receivers in the cars may provide additional documentation.

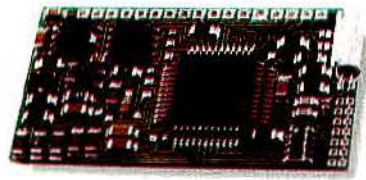
Radio's role in mobile communications may become invisible to customers, but successful businesses that supply or use communications services are making increasing use of radio through value-added technologies.

—Don Bishop



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## August

8-13—**Associated Public-Safety Communications Officers National Conference**, New Orleans Convention Center, New Orleans. Contact: 800-949-2726.

## September

21-23—**International Wireless Communications Expo/Fall**, Philadelphia Convention Center, Philadelphia. Contact: 303-220-0600.

28-Oct. 1—**Mobile Communications Marketplace**, New Orleans Convention Center, New Orleans. Contact: Telocator, 800-326-8638.

## October

12-13—**SMR/Private Carrier Management Conference**, Loews Coronado Hotel, San Diego, CA. Contact: 202-331-7773.

## November

4-6—**Industrial Telecommunications Association**, La Quinta Hotel, La Quinta, CA. Contact: Barbara J. Levermann, 703-528-5115.

11-14—**Communications Marketing Conference**, Holiday Inn Riverwalk, San Antonio. Contact: Gene Johnson, Vega Signaling, 818-442-0782.

19—**Radio Club of America**, Communications Symposium and Annual Dinner and Awards Presentation, New York Athletic Club, New York. Contact: Ron Formella, 201-652-6811.

## 1994

## February

7-8—**AMTEX**, the American Mobile Telecommunications Association's Marketing and Technology Conference and Exposition, Marriott on International Drive, Orlando, FL. Contact: 202-331-7773.

## March

2-4—**Cellular Telecommunications Industry Association Winter**

**Meeting and Exposition**, San Diego. Contact: 202-785-0081.

6-9—**Energy Telecommunications and Electrical Association**, Henry B. Gonzales Convention Center, San Antonio. Contact: 214-235-0655.

## April

13-15—**International Mobile Communications Expo/Spring**, Las Vegas Convention Center, Las Vegas. Contact: 303-220-0600.

## May

2-5—**Supercomm**, sponsored by USTA and TIA, and **International Conference on Communications**, sponsored by IEEE, New Orleans. Contact: USTA, 202-835-3100.

25-27—**RadioComm**, Vancouver Convention Center, Vancouver, British Columbia. Contact: Bill Eggertson, 613-233-4888.

## June

7-11—**Vehicular Technology Conference**, sponsored by IEEE Vehicular Technology Society, Stockholm, Sweden. Contact: Professor Sven-Olof Ohrvik, technical chairman, 46 8 757 0483; Fax 46 8 34 8441.

18-23—**Utilities Telecommunications Council**, Washington Sheraton, Washington, DC. Contact: Rita Clark, 301-621-7802.

## July

17-20—**Forestry-Conservation Communications Association**, Hershey, PA. Contact: Don Pfohl, 602-644-3166.

## August

6-11—**International Municipal Signal Association**, Cavanaugh's Inn, Spokane, WA. Contact: Harold Glerum, 800-723-4672.

7-12—**Associated Public-Safety Communications Officers National Conference**, Lawrence Convention Center, Pittsburgh. Contact: 800-824-1850



# Mobile Radio Technology

The journal of mobile communications technology

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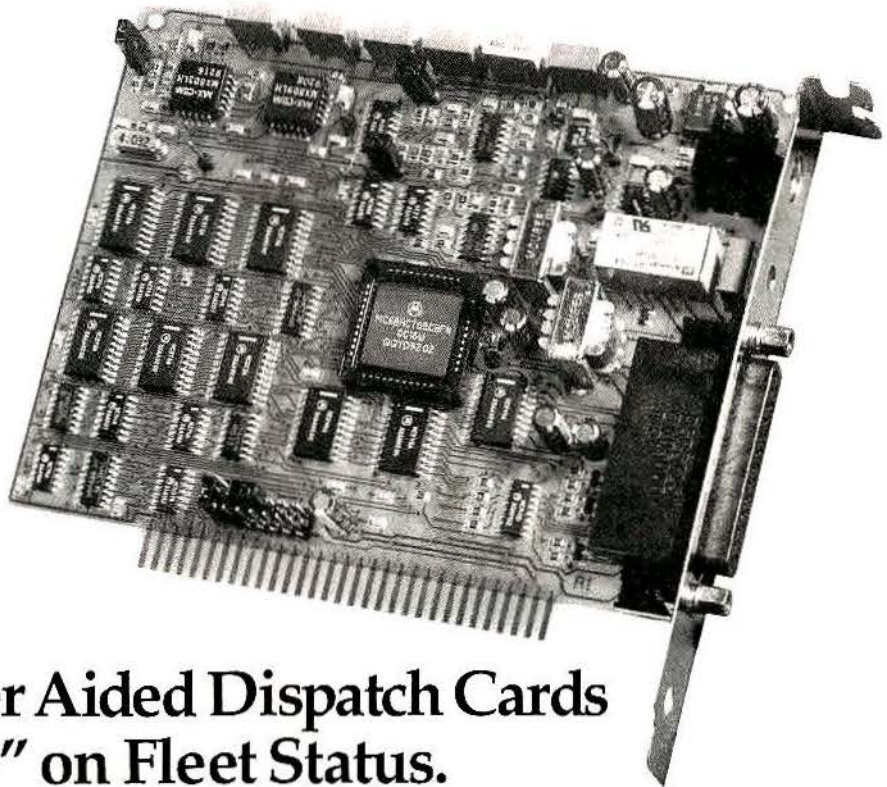


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Circle (7) on Fast Fact Card



## Field-tuning isolators

By Harold Kinley, CET

The June and July columns covered ferrite isolators in some depth.

It is time to put the subject aside for a while—right after these few tips about field-tuning or retuning isolators.

The first and probably the best advice to give about the field-tuning of isolators is to follow the manufacturer's instructions to the letter. After all, the manufacturer knows the limitations and capabilities of his isolator better than anyone else.

### General rules:

If possible, an isolator should be tuned in the installed position.

Generally, isolators should not be installed on a steel (or other ferrous metal) surface, but some manufacturers state that it is okay to do so as long as the tuning is "touched up" after installation.

If such isolators were tuned on a workbench and then installed on a steel

surface, it is likely that some detuning would result. The severity of the detuning would depend upon the degree of magnetic shielding the case provides.

Other manufacturers claim that their isolators are so well shielded that the mounting surface has a negligible effect on isolator tuning. Again, follow the manufacturer's instructions and use common sense.

### Signal source

If you use the transmitter output as the signal source for tuning the isolator, reduce the transmitter power output to about 10% of the normal isolator power input rating (not to exceed 10W) while tuning the isolator. Once the isolator is tuned, normal rated input power can be applied to the isolator.

There are many accepted methods by which an isolator can be properly tuned. These methods range from very simple to fairly complex. The method you use will depend on the type of equipment you have available and just how much of a "purist" you are.

The methods presented here are not a complete compilation of all the possible ways to tune an isolator. There are probably at least 101 ways!

► **Single-section isolator**—The single-section isolator is the simplest to tune.

First, remove the caps to gain access to the tuning adjustments. A single-section isolator has three adjustments: *input port*, *output port* and *load port*.

The following procedure uses an in-line directional wattmeter as the measuring instrument and the transmitter as the signal source. (See Figure 1 below.)

(1) Figure 1A. Key the transmitter (low power) and tune the input port (1) and output port (2) for maximum power indication on the wattmeter.

(2) Figure 1B. Reverse the connections to ports 1 and 2. Key the transmitter and adjust the port 3 trimmer for minimum power indication.

► **Dual-section isolator**—The following system is used for numbering the various tuning adjustments for the dual isolator discussed in these procedures.

- 1 = input port of first section.
- 2 = output port of first section.
- 3 = input port of second section.
- 4 = output port of second section.
- 5 = load port of first section.
- 6 = load port of second section.

**Procedure 1:** This procedure uses an in-line directional wattmeter as the measuring instrument and the transmitter as the signal source. Refer to Figure 2 on page 68 for this procedure.

(1) With the setup shown at Figure 2A, key the transmitter and adjust trimmers 1, 2, 3 and 4 for maximum power indication. Repeat this adjustment sequence until no further improvement can be made.

(2) Using the setup at Figure 2B, key the transmitter and adjust trimmer 5 (load port of first section) for minimum power indication.

(3) Using the setup at Figure 2C, key the transmitter and adjust trimmer 6 for minimum power indication.

(4) With the test setup at 2D and with the transmitter keyed, there should be no discernible indication on the wattmeter.

(5) Measure the insertion loss and the isolation. If both are not within the manufacturer's specifications, repeat  
(continued on page 68)

Kinley is a certified electronics technician with the South Carolina Forestry Commission, Spartanburg, SC. He is the author of *Standard Radio Communications Manual: With Instrumentation and Testing Techniques*, Prentice-Hall, 1985.

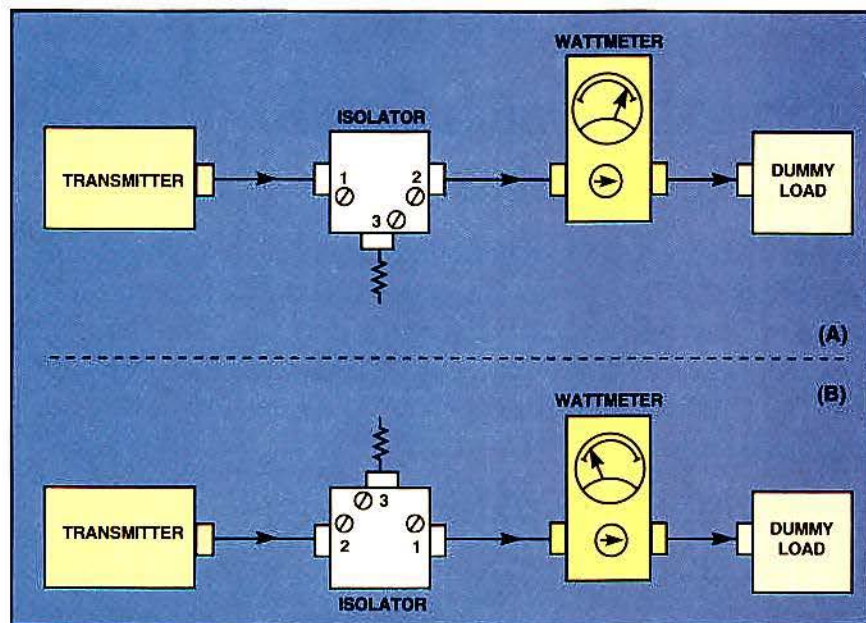
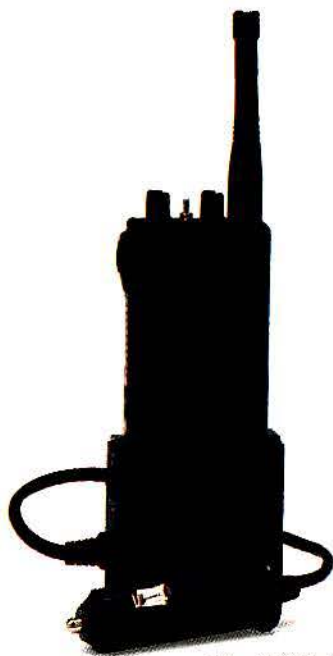


Figure 1. The single-section isolator is the simplest to tune. This diagram shows the equipment configurations to use with the two-step tuning procedure described in the text.



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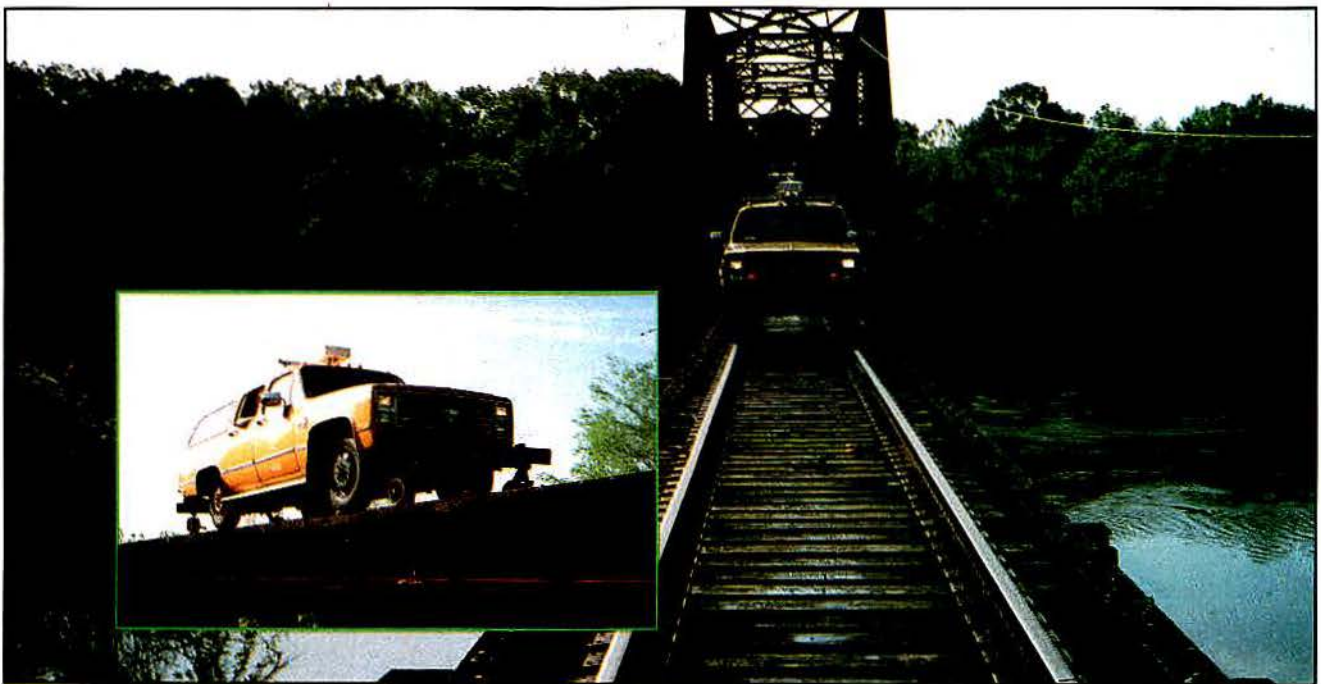


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# GPS-based vehicle location boosts productivity, safety

*Global Positioning System (GPS) equipment offers vehicle location solutions for land transportation companies and law enforcement agencies. A highly accurate version helps railroads to map their tracks.*



A Burlington Northern Railroad vehicle fitted with GPS-based AVL equipment maps tracks and the locations of company-owned equipment and facilities along the tracks.

**By Roald Steen**

An automatic vehicle location (AVL) system enables a dispatcher or an administrator to follow a mobile unit's progress on a computer screen as it moves along a road, railroad track or waterway. AVL systems are also of interest to the aviation industry.

Much of the communications between a mobile radio and a dispatch

Steen is an electronics instructor and free-lance writer. He has worked as a two-way radio technician, and he lives in Woodbury, MN.

center is intended simply to determine the mobile unit's location. This information can be important for a number of reasons, including scheduling vehicles and people; loading and unloading operations; and safety.

In addition, each vehicle's AVL system microprocessor may be programmed to use its automatic transmit capability to communicate vehicle condition data. Fuel quantity, oil temperature and pressure, and other engine and vehicle condition data can be transmitted over the same communications link as the AVL information.

Most AVL systems are composed of

a Global Positioning System (GPS) orbital satellite navigation system receiver, a microprocessor or a small computer and a mobile radio.

The AVL system in a vehicle may be composed of a GPS satellite navigation receiver, a mobile radio and an RF modem.

In addition to a base station or other radio communications system, the dispatch or fixed location needs computers or computer terminals and a geographic database. The geographic database may account for a significant part of the cost of an AVL system.

The GPS receiver determines the



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vehicle's location. The microprocessor receives this information, formats it into a brief data message and transmits it automatically at intervals over the mobile radio through the modem.

A mobile unit with GPS-based AVL must have at least two antennas: a specialized GPS receiver antenna and a mobile radio antenna to transmit AVL information to the dispatch center.

The dispatch equipment is composed of a radio communications system and a computer with a geographic database to display locations.

The computer can tell more than simply where the mobile unit is. As it records mobile unit position changes over time, the computer can calculate speed, estimated time of arrival to a destination, distance travelled and the

direction the mobile unit is traveling.

#### Radio communications problems

AVL systems transmit frequent but brief data messages from each vehicle.

The messages contain identification, position as received over the radio navigation receiver and little else. For communications, an existing radio communications system may be adapted for AVL use. AVL data messages may be transmitted over a voice communications channel, with voice communications usually given priority.

Potential AVL users are trucking companies, bus companies, shipping lines and other transportation companies that operate over wide areas.

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*... the computer can  
calculate speed,  
estimated time of arrival  
to a destination,  
distance travelled and  
the direction the mobile  
unit is traveling.*

Many of these companies do not operate their own wide-area radio communications systems. Instead, they rely on pagers, wireline and cellular telephone and, in some cases, satellite communications.

Most such communications systems are designed to handle voice communications efficiently. Voice communications generally are infrequent but relatively long, whereas AVL data communications are frequent but relatively short. Placing AVL communications on a system designed for voice can be expensive if the charges are based on airtime, as with cellular telephone.

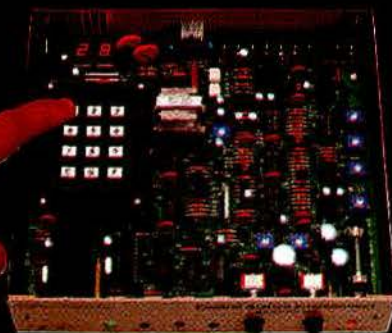
For example, cellular telephone conversations may be charged by the minute, even when a conversation is quite short. Satellite voice communications (over the Inmarsat satellites)



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are charged for each 6 seconds, but the rate for this service is quite high.

The new digital cellular radio telephone systems which are being introduced in the United States, Canada and Europe may be more adaptable to the communications requirements of an AVL system. AVL systems may represent a huge potential revenue source for the digital

cellular telephone industry.

#### GPS

The GPS and its Russian counterpart, the GLONASS system, are the most accurate and advanced of a number of wide-area navigation systems based on radio signals. The GPS will include 24 satellites when complete.

It will provide 24-hour three-di-

mensional position information anywhere on earth. Although GPS originally was designed for the U.S. Department of Defense, it and GLONASS are available for civilian use, according to an international agreement.

The GPS includes a highly accurate operating mode that locates a receiver within 3 meters, but that mode is not available to civilian users; nevertheless, the mode available for civilian use is sufficiently accurate for all but the most demanding AVL applications.

Four satellites must be within the receiver's view to determine location accurately in three dimensions. The GPS receiver determines its position algebraically through a calculation involving four uncertainties, hence the need for information from four satellites.

GPS satellites transmit information on two frequency bands, 1.57542GHz and 1.2276GHz.

The satellites orbit the earth in high orbit, 12,500 miles above the surface.

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*Although GPS originally was designed for the U.S. Department of Defense, it and GLONASS are available for civilian use . . .*

Although the system still lacks several satellites of having its full complement, with the present number of satellites in orbit, quite accurate positions can be determined on the ground nearly 24 hours each day.

The lack of the remaining satellites affects primarily the aviation industry, which needs three-dimensional position fixing.

There are two main types of GPS receivers, multichannel and single-channel receivers.

The multichannel GPS receiver is the more advanced and expensive of the two. It can receive information from several satellites simultaneously.

The single-channel GPS receiver



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takes longer to determine a position because it can receive data from only one satellite at a time.

The single-channel GPS receiver shifts sequentially from satellite to satellite to determine its exact location, and it generally consumes less power than the multichannel receiver, making it more suitable for portable applications.

#### Loran C

Another radio navigation system, Loran C, covers the United States and Europe well.

Loran C uses *chains* of *primary* and *secondary* radio navigation transmitters. Originally, a signal from the primary station was retransmitted by the secondary stations, but now the secondary stations generate their own transmissions at exact intervals with the help of highly accurate atomic clocks.

The reception delay between a signal received from a primary station and a secondary station depends upon the

location of the receiver. The difference corresponds to a *line of position* (LOP) on the navigation map. Loran C is called a *hyperbolic* navigation system because LOP patterns look like hyper-

---

*The single-channel GPS receiver takes longer to determine a position because it can receive data from only one satellite at a time.*

---

bolic lines drawn over the navigation map.

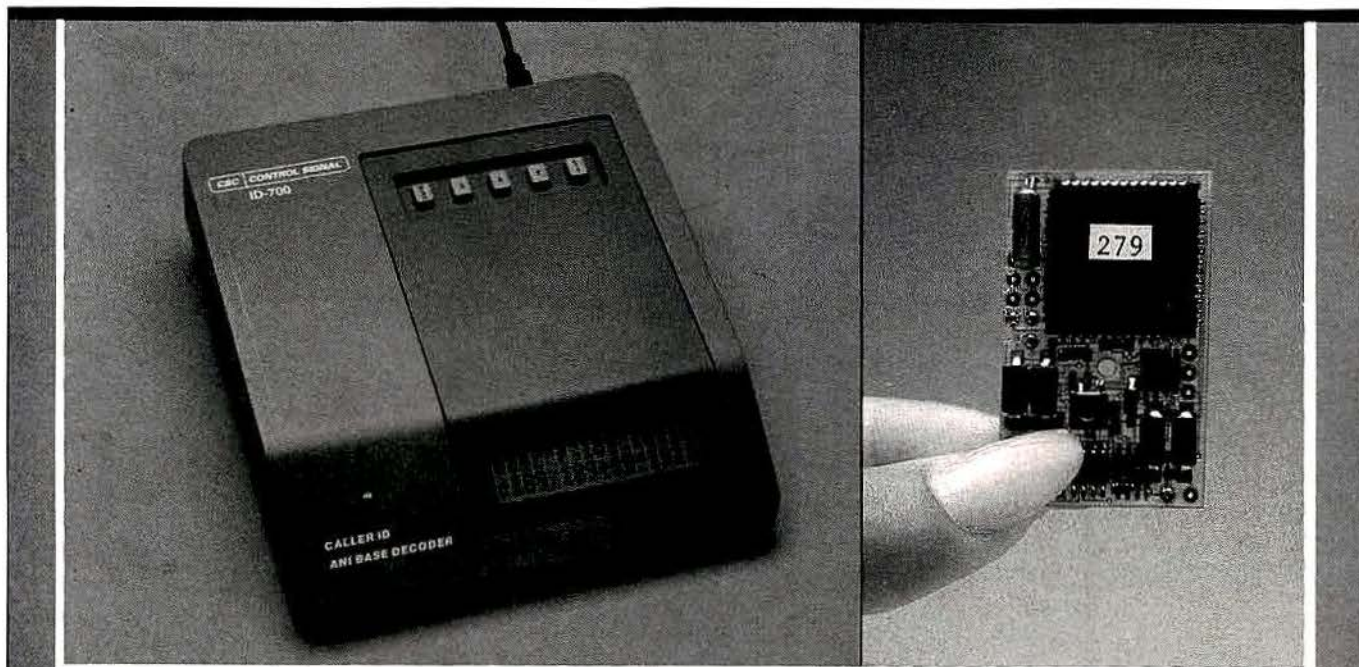
The reception time difference between the primary station and another secondary station signal corresponds to another LOP. Where the two lines intersect defines the receiver location.

Modern Loran C receivers use microprocessors that automatically identify the primary and secondary stations and calculate the receiver location automatically. Actually, the distinction between the primary and the secondary stations is less significant now than it was prior to the use of microprocessors because microprocessor-equipped Loran C receivers can determine an LOP from two secondary stations' signals as easily as from signals from a primary and a secondary station.

Some of the GPS satellites may be obscured from a receiver by tall buildings in a metropolitan area or by foliage or hills near the highway. To overcome such problems, Loran C may be combined with GPS.

Loran C's low radio frequency has a long wavelength that propagates mostly along the ground, so its reception is not influenced significantly by landscape obstructions.

Decca is a well-developed radio navigation system in Europe that uses a principle similar to Loran C.



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The very low frequency (VLF) Omega system is a hyperbolic radio navigation system with worldwide range. Unfortunately, Omega is impractical for AVL systems because its accuracy is low, and the receivers are relatively expensive.

Even an AVL system combining GPS and Loran C has limitations. For example, it does not work in a tunnel.

Many roads and railroads in mountainous and metropolitan areas have numerous tunnels.

#### Triangulation

An AVL system requiring less complicated equipment in each vehicle can be designed by placing a number of receivers at various metropolitan-area locations.

Each receiver accurately records each radio transmission's arrival time. Vehicle position is calculated by a computer through triangulation for any transmission with a vehicle identification code.

California state agencies are among the users of these effective AVL systems. One advantage of a triangulation-based AVL system is that the mobile installation in each vehicle may be less expensive and less complicated.

As with GPS-based AVL systems, triangulation-based AVL systems display each vehicle's position on a computer screen through a geographic database.

An AVL system using triangulation is inexpensive and less complicated because it operates without the GPS receiver and antenna. A triangulation-

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*Because of the low data rate, Inmarsat C can use much smaller antennas than the original Inmarsat voice communications system.*

based AVL system is most effective when it is designed for limited coverage, such as a metropolitan area.

#### Using Inmarsat C

Geostationary Inmarsat satellites are designed to provide communications between ships at sea and the worldwide telephone and teletype network.

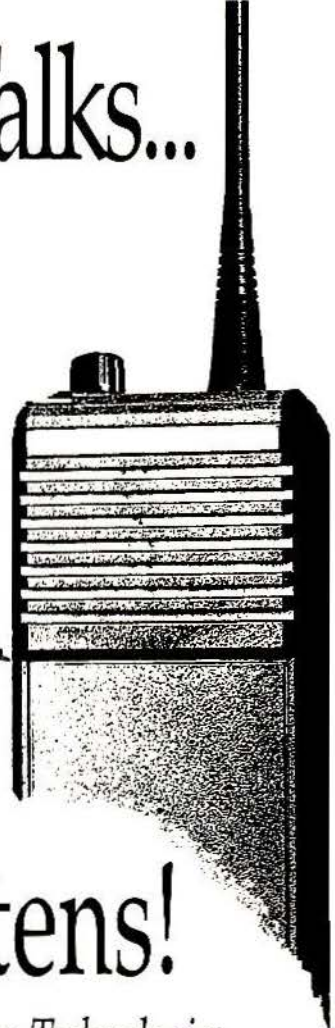
The original Inmarsat system was designed for voice communications and required relatively large mobile antennas. Inmarsat C is a newer service that provides mobile data communications at a relatively slow data rate.

Because of the low data rate, Inmarsat C can use much smaller antennas than the original Inmarsat voice communications system. Inmarsat C uses the same four geostationary satellites as the original Inmarsat service, which now is called Inmarsat A, and which provides voice and teletype service.



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Inmarsat C is used as the communications link for an AVL system that Radio Satellite Integrators, Torrance, CA, has designed for the South American trucking industry.

GPS receivers in each truck provide position information. These trucks often travel over relatively little-used roads, so the AVL system improves driver and equipment safety.

According to Newlin Warden, Radio Satellite's vice president of marketing, each AVL message sent via the Inmarsat C system costs between 10 cents and 20 cents.

Many fishing vessel operators need to document their voyages and positions accurately because of *economic zones* at sea that various nations claim. A substantial fine and even the seizure of the catch may result when a vessel operator is accused of unauthorized fishing in another country's economic zone.

An AVL system with a geographic database may provide a fleet of fishing vessels voyage documentation sufficient to avoid such problems.

Another AVL system supplier, Coded Communications, Carlsbad, CA, usually supplies GPS-based systems, although the company can supply AVL systems that use data from Loran C.

Among Coded's customers are the San Francisco Bay Area Metropolitan Transportation Commission and the Los Angeles County Transportation Commission.

#### **Burlington Northern**

The railroad industry needs mobile unit location equipment, too.

The Burlington Northern Railroad is conducting an experiment by operating GPS-based AVL systems on 17 locomotives based in Northern Minnesota. The AVL system allows the dispatcher to follow a train's progress accurately. A railroad relies on a complicated system of scheduling railroad cars, cargo and track assignments, and accurate information on the whereabouts of each train helps to keep the schedule functioning smoothly.

Burlington Northern owns an advanced radio communications system that serves almost all its huge track system. The radio system uses frequen-



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cies allocated to the Railroad Radio Service, and it was easy to adapt it for the AVL experiment.

#### Differential GPS

Ordinary GPS accuracy is on the order of a few hundred feet, which normally is accurate enough for most AVL applications.

For applications that require higher

accuracy, an extremely accurate GPS mode called *differential GPS* has been developed.

All GPS receivers within a sizeable area encounter about the same error in determining their position. The error can be calculated at a known location by comparing the known location with the GPS-calculated location.

The GPS receiver at the known lo-

cation broadcasts the *differential error* to other differential GPS receivers in the area. By subtracting the error from their calculated positions, these receivers compute another position that is accurate within a few feet.

Differential GPS used to be a fairly expensive technology. Now, differential receivers that can be connected to many ordinary GPS receiver models are available, some for less than a thousand dollars.

A standard RTCM-104 connector connects the differential receiver to the GPS receiver.

Burlington Northern Railroad is using differential GPS to map its tracks more accurately. The positions of signal masts, mile posts, bridges, huts and road crossings along the tracks must be mapped as accurately as possible. The differential GPS system's high accuracy enables the railroad to record many of these structures' positions more accurately than before.

There are several interesting potential differential GPS applications.


Precise navigation in congested waters and harbors, automatic landing systems and land surveying are among these applications, some of which are being tried in experimental programs. Because determining vehicle locations at an airport when visibility is poor sometimes is difficult, Chicago's O'Hare International Airport is conducting an experiment in which some airport vehicles are equipped with an extremely accurate differential GPS-based AVL system.

#### Conclusion


An AVL system solves an old problem within the transportation industry and the law enforcement community, namely, knowing where a mobile unit is.

A lack of suitable radio systems with wide-area coverage is one obstacle to more widespread AVL use. By adopting tariffs and communications systems suitable for the short but frequent data messages that AVL-equipped vehicles transmit, the cellular industry and other parts of the mobile communications industry may attract AVL users and a new source of revenue.




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IP-DN



# Portable radio communications on a digital wireless network

*Command and control data coexist with voice data on a spread-spectrum digital wireless voice network to form a portable radio system especially suitable for industrial communications requirements.*

By W.K. 'Chuck' Lau

Communications requirements are as different from one industry to the next as one set of fingerprints is different from another.

Most industrial facilities use a variety of communications devices, including wired headsets, two-way radios, walkie-talkies, pagers, cordless telephones and cellular telephones. One type of communications system combines all of these devices' functions and provides versatility and flexibility for multiple applications.

## Communications problems

Industrial requirements generally include effective, unencumbered and

uninterrupted team communications in a noisy environment.

Usually, it must be possible to integrate industrial communications equipment with other communications devices. Most existing communications systems are analog; therefore, they are prone to interference and cannot be switched to or mixed with other speech paths easily.

Some available analog systems use a repeating base station and as many as eight remote wireless headsets to provide unencumbered team communications. The repeater has one common transmit channel and several receive channels, each of which corresponds to one remote unit.

The repeater listens to the remote units via the receive channels, sums the signals and broadcasts the combined conversation to all units on the common transmit frequency. The result is a *full-duplex party line* that satisfies

some industrial requirements, but it lacks the flexibility and speech quality required for certain applications. Furthermore, an FCC license usually is required for such a system.

A 1985 change in FCC Part 15 low-power transmitter rules allows the use of transmitters with as much as 1W spread-spectrum RF output in three frequency bands for commercial purposes. This change spawned a score of new wireless data and voice communications products.

Unfortunately, most of the new products were handset-based devices for office use. They tend to work as closed systems that leave little room for modification or connection with other devices.

## Another solution

To satisfy communications requirements for most industrial environments, a microcellular-like *digital wireless voice network* was designed.

The network's core technologies include spread-spectrum modulation, data packetization, adaptive differential pulse-code modulation (ADPCM) speech processing, frequency-division multiple-access (FDMA), time-division multiple-access (TDMA), antenna diversity and echo cancellation.

The network consists of a system controller, external radio units and portable communication units. At its heart is a microcomputer-controlled system controller with customized control software.

The system controller is connected by as much as 1,000 feet of cable to as many as four external radio units. Each

Lau is president of Telenexus, Plano, TX. The company's TNEX-2000 digital wireless voice network is used as an example in this article.

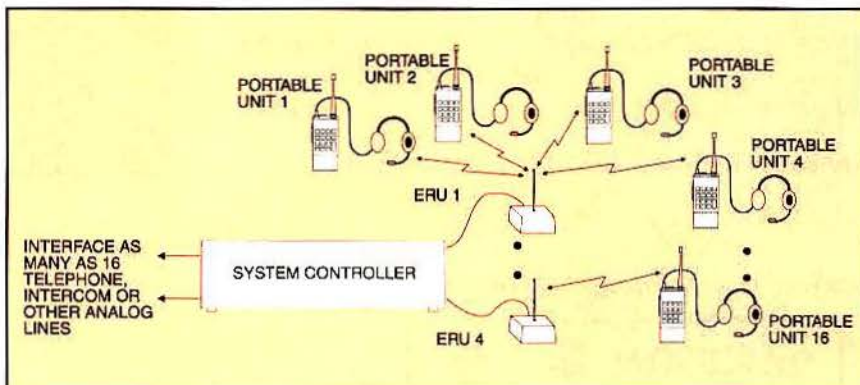


Figure 1. The system controller is connected by as much as 1,000 feet of cable to as many as four external radio units. Each external radio unit supports as many as four personal communication units that can be configured to one of four time-multiplexed channels for a system capacity of 16 portable units.





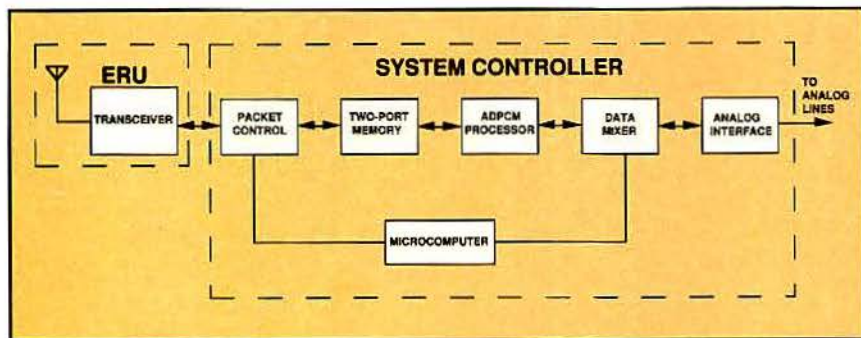
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**Figure 2.** The system controller consists of a transceiver in the external radio unit; a microcomputer; a packet controller; a two-port memory; an ADPCM processor that is a voice coder and decoder; a data mixer; and an analog lines interface.

external radio unit supports as many as four personal communication units that can be configured to one of four time-multiplexed channels for a system capacity of 16 portable units. (See Figure 1 on page 24.)

Because the system architecture is modular, one can start with a simple configuration with one external radio unit and two portable communication units and gradually expand the capacity. The portable units offer hands-free,

full-duplex communications within a 500-foot radius (on the average) of the corresponding external radio unit.

#### Digital control

Because it is digitally controlled, the network is flexible, accommodating a wide range of selective calling requirements.

The user can mix and match several modes of operation that include private call from one personal communi-

cation unit to another; conference call; conference monitoring; make and receive telephone calls; interconnect with other intercom systems; and interconnect with one or more system controllers.

Each portable unit has a unique two-digit identification number and keypad. Functions such as dialing and receiving are implemented on the keypad. If centralized control is required, a display and keyboard option is available at the system controller.

If the system controller is connected to the telephone system, personal communication units can place and receive telephone calls whenever necessary. The user can mix conversations with portables and telephone calls. The system can be expanded by interconnecting as many as four system controllers or by connecting an existing intercom.

An auxiliary antenna connected to the external radio unit provides antenna diversity to counter multipath interference. Two external radio units can be placed on the same frequency

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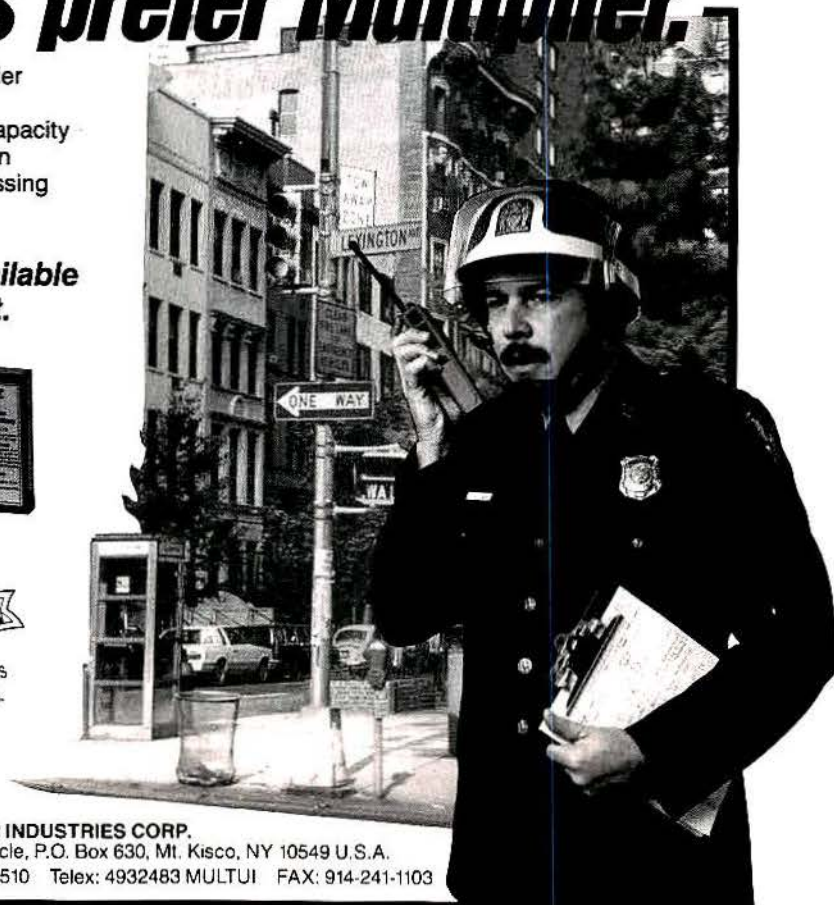
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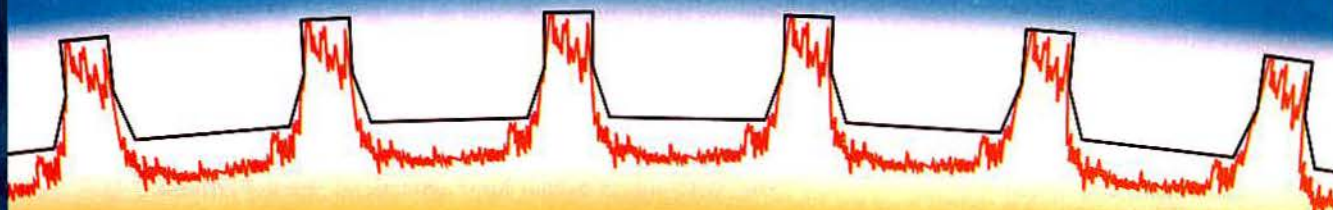
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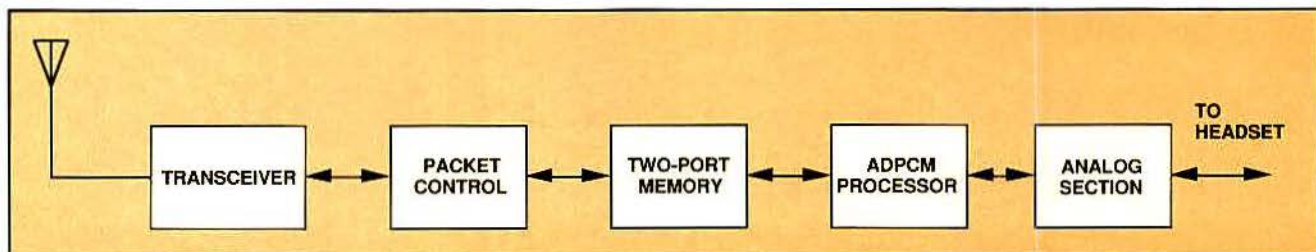


Figure 3. The portable radio communication unit consists of a transceiver, a packet controller, a two-port memory, an ADPCM processor and an analog section for the headset.

to expand the coverage area and to eliminate dead spots.

For operation in certain environments, multiple cells of the same frequency can be created for continuous communications in several locations. In this application, as many as eight external radio units can operate in the same frequency band, and a hand-off controller automatically switches the connection to the external radio unit cell where a personal communication unit is active.

The system controller works as a network controller, an audio mixing

network and an interface to outside services such as computers, telephone networks, an intercom and another system controller.

Communications between the system controller and the personal communication units take place over a digitally modulated radio link. The protocol is such that the personal communication units reply to messages from the system controller; thus, the system controller operates as a master controller with the personal communication units operating as slaves.

Each personal communication unit

falls into a *time slice*. The personal communication units are queried sequentially. A query contains a packet header, an address for the personal communication unit, some control information and an audio packet.

The designated end unit updates its controls according to the control information and generates voice according to the audio packet. The audio packet contains enough information to generate the proper voice until the next packet arrives.

As soon as the query packet has been received, a response packet is sent. This

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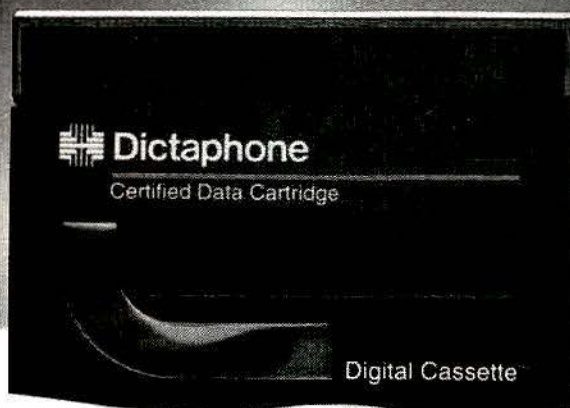
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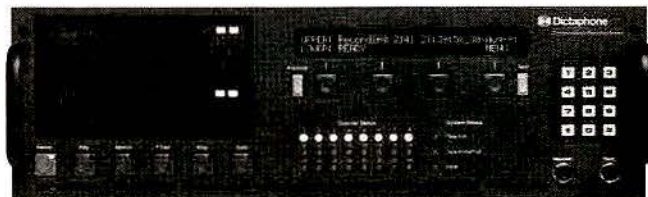
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The Telenex TNEX-2000 is one example of a microcellular-like digital wireless voice network that satisfies communications requirements for many industrial environments. The network operates in the 902MHz-928MHz band and does not require an FCC license.

## Advanced Features, New Design



The future of **EXTENDED LOCAL CONTROL** is here. The new model LE10 from CPI is a telephone style local extension designed for easy use with virtually any radio. The LE10 provides LED PTT indication, on-hook PTT capability, off-hook monitor, amplified speaker with volume control and adjustable amplified modulation output. The LE10 allows you to hear both sides of a transmission made from another desk-set or the radio microphone. The LE10 gives you all this in a newly styled modern package that brings extended local control into the 90's. Options: wall-mount

adapter, two channel control, intercom, on-hook monitor and plug-in power-pack.

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response has the same form as the query. There is a packet header, an address, some control information and an audio packet. The audio packet contains all of the digitized voice information accumulated since the last response packet was sent.

The system controller consists of a transceiver in the external radio unit; a microcomputer; a packet controller; a two-port memory; an ADPCM processor that is a voice coder and decoder; a data mixer; and an analog lines interface. Figure 2 on page 26 is a block diagram of the system controller.

The portable communication unit consists of a transceiver, a packet controller, a two-port memory, an ADPCM processor and an analog section for the headset. Figure 3 on page 28 is a block diagram of the personal communication unit.

Performance data for the digital wireless voice network have been gathered for several months.

► *Analog noise immunity*—Because communication with the end instruments is entirely digital, the system is immune to analog noise that typically occurs with analog systems.

The speech quality does not change with distance. When the personal communication units are used at maximum range, the system starts to lose information packets, which results in breaks in the conversation; nevertheless, the speech quality of the received portion is unchanged.

► *Security*—Spread-spectrum modulation, which uses an RF bandwidth much wider than necessary to transmit voice information, offers the potential to improve the signal-to-noise ratio.

The desired information is spread across a wide band of frequencies, which offers secure communication that is protected from eavesdropping, as well as some immunity to interference.

► *Reduced mutual interference*—Spread-spectrum modulation is capable of reducing mutual interference with other systems operating at the same frequency. The improvement results from the processing gain achieved by spread-spectrum techniques.

The network has been tested with another spread-spectrum telemetry product operating at the same frequency

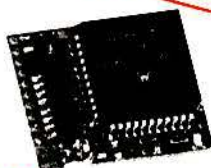


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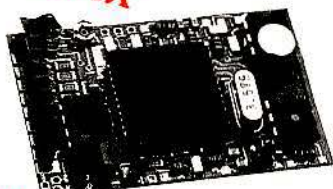
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with different spreading code without mutual interference.

► **Multipath interference solution**—Multipath interference results from radio wave propagation in which a receiver receives the same signal via two or more paths because of reflections or diffractions.

Phase differences among the paths' signal components caused by differ-

ences in path length and phase shifts from the reflected wave may cause the signal components to cancel or reinforce, depending on the wavelength and the position of the receiver. When the radio waves cancel one another at a *null* in the multipath interference pattern, intermittent communication results.

The digital wireless voice network

uses a diversity antenna to solve the multipath interference problem. Two antennas placed more than one wavelength apart are connected to the external radio unit. The external radio unit selects the antenna that provides the best communication.

Because the probability of a multipath null appearing at both antennas at the same time is small, the multipath interference problem is greatly reduced.

► **Echo cancellation**—Speech delay and audio echo are inherent problems with digital communications.

The network's analog line interface board has an echo cancellation circuit to counter potentially serious echo problems with telephone and intercom connections.

► **Low current**—Because of its highly integrated design, the network consumes little electrical current.

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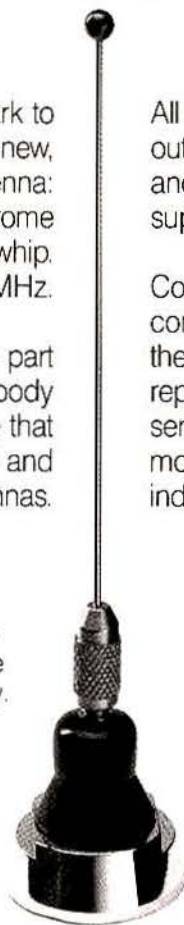
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*The digital wireless voice network uses a diversity antenna to solve the multipath interference problem.*

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Because the network is a true digital communications system, command and control data can coexist with voice data to make the system a dual voice-and-data product.

After two years of product development and testing funded partially by the National Aeronautics and Space Administration's Kennedy Space Center, Cape Canaveral, FL, the digital wireless voice network has proved to be reliable and versatile for industrial communications.

The network can work as a stand-alone wireless system, or it can be connected with most existing communications systems to improve overall communications capability and efficiency.



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# APCO national conference '93 preview/guide

More than 200 exhibitors will display their products and services during the 59th Associated Public-Safety Communications Officers annual conference and exposition in New Orleans.

More than 4,500 public safety professionals will convene at the Louisi-

ana Superdome Aug. 8-12 to examine the latest technology firsthand and explore the future in public safety communications offerings.

Conference sessions include technical, 9-1-1, information systems, management and training forums. Topics include mobile data communications; planning and implementing a regional 800MHz radio system; 9-1-1 information; training dispatchers; automatic emergency vehicle tracking; mobile command posts; and technological developments in the public safety market.

For a rundown on sessions, refer to the session schedule in the APCO program.

The exhibition spans two days (Aug. 10-11), and seminars cover four days.

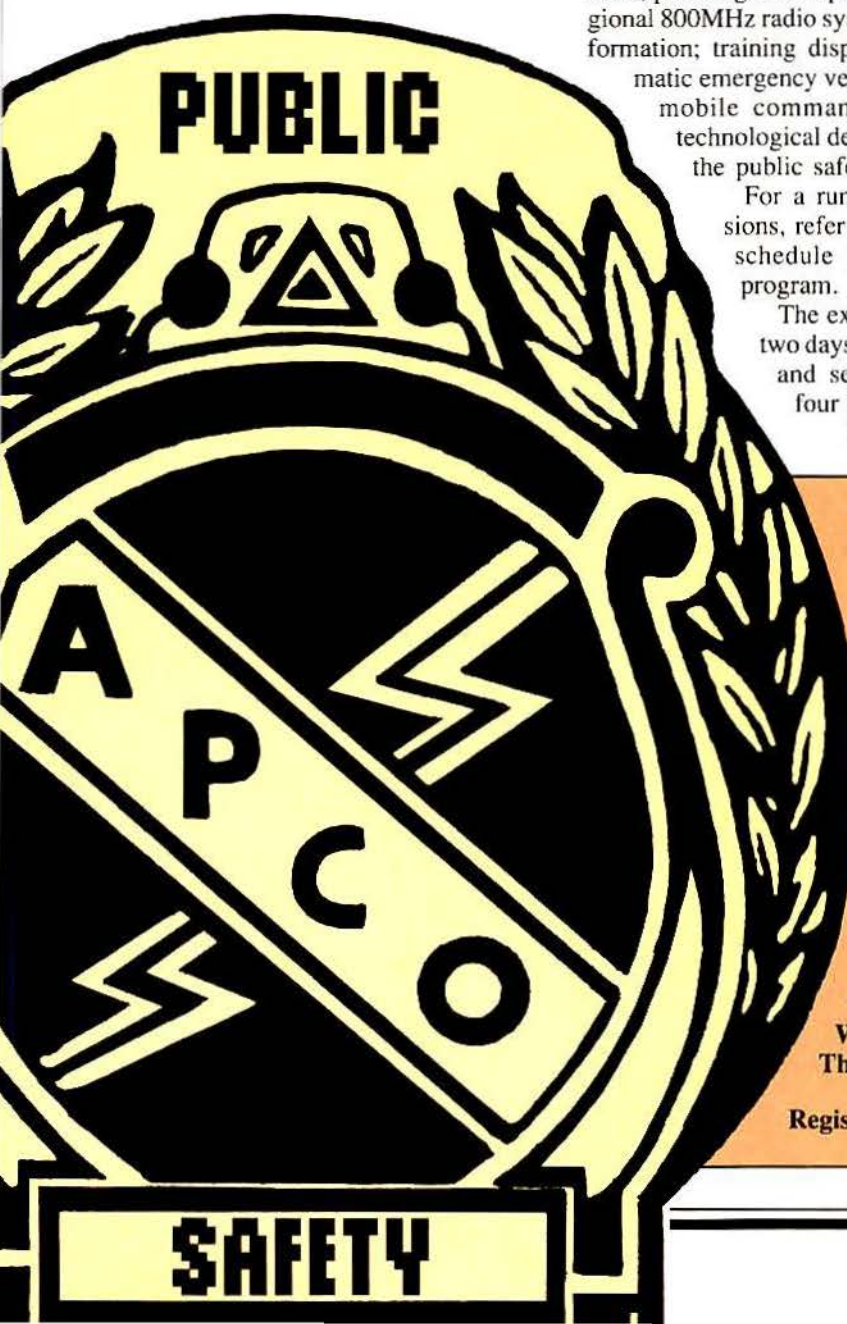
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venience, *Mobile Radio Technology* has compiled a list of the exhibitors and a section on their new and existing products and services that will be displayed at the Superdome.

Use this section to "preview" exhibits and as a guide to products and services offered by the various manufacturers. Corresponding Fast Fact numbers for products and services may be circled on the card in the back of the magazine to obtain more data from the vendors. Advertisers in the section are highlighted in blue with a page number reference to their ads, so you can refer to the ads for additional information.

Use the show floor map on page 36 in combination with the exhibitor list complete with booth numbers to find companies' booths at the conference.

The pre-show guide includes information that was available as of press time.



**Event:** Associated Public-Safety Communications Officers 59th Annual Conference

**Dates:** Aug. 8-12

**Location:** Louisiana Superdome

**City:** New Orleans

**Number of Exhibitors:** More than 200

**Projected Attendance:** 4,500

**Exhibit Hours:** Tuesday, Aug. 10, 10 a.m. to 5 p.m.  
Wednesday, Aug. 11, 10 a.m. to 5 p.m.

**Seminar Hours:** Monday, Aug. 9, 1 p.m. to 5 p.m.  
Tuesday, Aug. 10, 8-10 a.m. and 1-5 p.m.  
Wednesday, Aug. 11, 1 p.m. to 5 p.m.  
Thursday, Aug. 12, 8 a.m. to 5 p.m.

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				318	419					518	619					718	819						1018	1119					1218	1319						
				316	417					516	617					716	817						1016	1117					1216	1317						
	208			314	415					514	615					714	815							1014	1115				1214	1315						
				310	411		410	511		510	611		610	711		710	811		810	911		910	1011		1010	1111		1110	1211		1210	1311				
				308	409		408	509		508	609		608	709		708	809		808	909		908	1009		1008	1109		1108	1209		1208	1309				
				306	407		406	507		506	607		606	707		706	807		806	907		906	1007		1006	1107		1106	1207		1206	1307				
				304	405		404	505		504	605		604	705		704	805		804	905		904	1005		1004	1105		1104	1205		1204	1305				
				302	403		402	503		502	603		602	703		702	803		802	903		902	1003		1002	1103		1102	1203		1202	1303				
				300	401		400	501		500	601		600	701		700	801		800	901		900	1001		1000	1101		1100	1201		1200	1301				

APCO '93

SUPERDOME

New Orleans,

Louisiana

August 8-13, 1993

100	102	103	104	105	106	107
108	109	110	111	112	113	114

MRT ▲

**APCO '93**  
**SUPERDOME**  
**New Orleans,**  
**Louisiana**  
**August 8-13, 1993**





## Imagine a radio that adapts to your changing needs.

### Imagine FLASHport radios.

It used to be you bought a radio hoping it had everything you needed for now and years to come. So you either overbought features or planned on a short lifespan. Then came FLASHport.™

Now with FLASHport, the radio you purchase today can be flexible enough to be upgraded tomorrow with additional features or future technology enhancements by simply loading new software.

Instead of buying a brand new radio, you can simply purchase and load new software into your FLASHport radio. Similar to how personal computer users load software into their PCs to get the most out of their PCs.

Buy only what you need today, and grow as your needs grow. Even provide the same radio hardware to all users, but vary application software according to the needs of different groups within your department. And do it all yourself.

FLASHport technology incorporates Motorola's proprietary ROS/VRIS™ operating system



and is exclusively available on many of our two-way radios: MTS 2000™, SABER™ SI, ASTRO™ Saber, ASTRO™ Spectra, plus other planned future products.

To learn more about how you can change your mind tomorrow, without needing to change the radio hardware you buy today, just contact us.

 **FLASHport™**



**Land Mobile Products Sector**  
1301 East Algonquin Road  
Schaumburg, IL 60196  
Phone: 1-800-635-9837

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Learn about FLASHport at the Motorola APCO Booth.

Circle (32) on Fast Fact Card



## Exhibitor List

9-1-1 Magazine (105)  
 911 Mapping Systems (114)  
 Advanced TechCom (1335)  
 Alcatel (1328-1332)  
 Alexander Batteries (607)  
 Allen Telecom Group (801-805)  
 Allgon Mobile (1216)  
 Andrew (1122)  
 Antenna Specialists (801-805)  
 Appropriate Data Communications (109)  
 Armata Technologies (809, 811)  
 AT&T (1114)  
 Avtec (617, 619)  
 Ball Systems Engineering (705)  
 Bally Engineered Structures (1007)  
 Bear Communications (900)  
 Bell Atlantic Public Sector Systems (934-1039)  
 Bendix/King Mobile Communications Div. (909, 911)  
 Bomar Crystal (1020)  
 Cadex Electronics (709)  
 Call One (410)  
 Carter Engineering (504)  
 Cellular Business (508)  
 Celwave (808, 810)  
 Centurion International (735, 737)  
 CML Technologies (102, 104)  
 Coded Communications (1314, 1315-1325)  
 Combined Technologies (1022)  
 Communications Associates (711)  
 Communications Data Services (506)  
 CommuniTech (804)  
 Concepts-to-Operations (609)

Dataradio (336A)  
 Decibel Products (801-805)  
 Delco/Hughes Automotive (603, 605)  
 Deltarcom Communications Services (1043)  
 DFE Communications (1142)  
 Dictaphone (1136)  
 Digital Recorders (906)  
 Dispatch Products (627)  
 Domore Seating & Systems (1121)  
 DX Radio (108)  
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 E. F. Johnson (714-825)  
 ElectroCom Communications Systems (842-947)  
 Emergency Information Services (1209)  
 Ericsson GE Mobile Communications (614)  
 FailSafe Magnetics (1018)  
 Federal Signal (843)  
 Flash Technology (1311)  
 Fleet Safety Equipment (1110)  
 Fluor Daniel (905, 907)  
 Fujikura/Teletec (1103)  
 Gamber-Johnson (902, 904)  
 GE Capital Public Finance (113)  
 GTE Government Information Services (414)  
 Haddcomm International (942)  
 Harris (532-633)  
 Harris Farinon (528, 530, 629, 631)  
 HBF Group (1200, 1202)  
 Heischmann (1104)  
 Hewlett-Packard (600)  
 Hitech Systems (1105, 1107)  
 HTE Public Safety (1143)  
 Hughey & Phillips (1115)  
 IFR Systems (510)  
 Informer Computer Systems (538)  
 Intergraph (428)

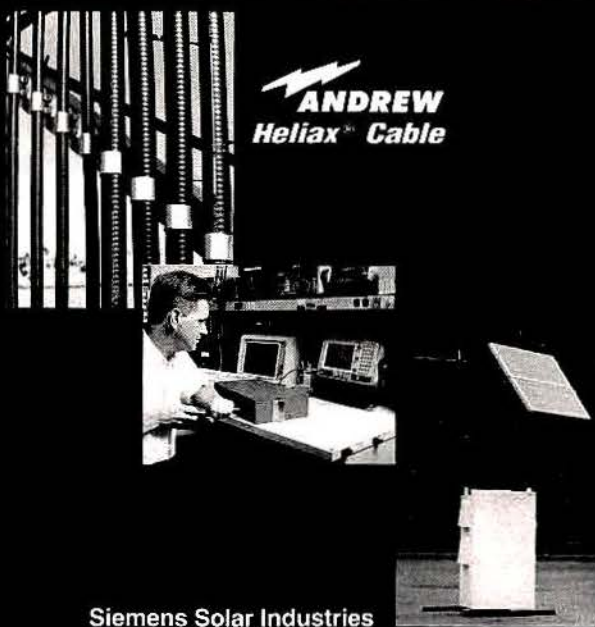
Jon/Beau (1201)  
 Kenwood USA (436)  
 Law Enforcement Product News (1422, 1424)  
 Law Enforcement Tech/PTN Publishing (1006)  
 Leach Mounce Architects/Scheme Systems (101)  
 LocRad (706)  
 Logistic Mapping (525)  
 Logistic Systems (1003, 1005)  
 Lynch Display Vans (LDV) (228)  
 Magnasync/Comverse (708, 710)  
 Mark Systems (702)  
 MaSys (1009)  
 Maxon America (507)  
 Maxrad (1109, 1111)  
 McCaw Cellular Communications (908)  
 Medical Priority Consultants (524)  
 Melillo Consulting (1024)  
 Metroplex Mobile Data (739)  
 Microwave Radio (536)  
 Midland Land Mobile Radio (1308)  
 Mobile Data Communications (704)  
 Mobile Mark (1100, 1102)  
 Mobile Radio Technology (508)  
 Modular Communications Systems (628)  
 Motorola (814)  
 MPI (336B)  
 MX-Com (543, 545)  
 National Emergency Number Association (NENA)  
 (Booth not assigned)  
 National Safety Systems (903)  
 NEC America (707)  
 New World Systems (1042)  
 Northern Technologies (1242)  
 O A R (1001)  
 OCS Technologies (403, 405)  
 Orbacom Systems (606-610)

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 FAX-446-5779  
 800-325-8950

Communications Works  
 Denver, Colorado  
 303-820-2929  
 FAX-820-2809  
 800-726-6245





# Imagine a radio that keeps learning new technologies.

## Imagine FLASHport radios.

Change is inevitable. Especially in radio communications technology. Until now, however, change was also expensive. Because it meant throwing away radios with outdated technology. Then came FLASHport.™

Now the radio you purchase today can be "taught" additional features or future technology enhancements by simply loading new software.

Whatever tomorrow brings—new trunking systems, new encryption features, APCO 25 digital standards—with FLASHport, you buy what you need now, and add the features you want as your needs change in the future. Instead of buying a

brand new radio, you simply purchase and load new software into your FLASHport™ radio. Similar to how personal computer users load software into their PCs to get the most out of their PCs.

FLASHport technology incorporates Motorola's proprietary ROS/VRIS™ operating system and is exclusively available



on many of our two-way radios: MTS 2000™, SABER™ SI, ASTRO™ Saber, ASTRO™ Spectra, plus other planned future products.

No matter what tomorrow's communications technology will bring. With a radio that "learns", you can be prepared. Just contact us.

 **FLASHport™**



**MOTOROLA**

**Land Mobile Products Sector**  
1301 East Algonquin Road  
Schaumburg, IL 60196  
Phone: 1-800-635-9837

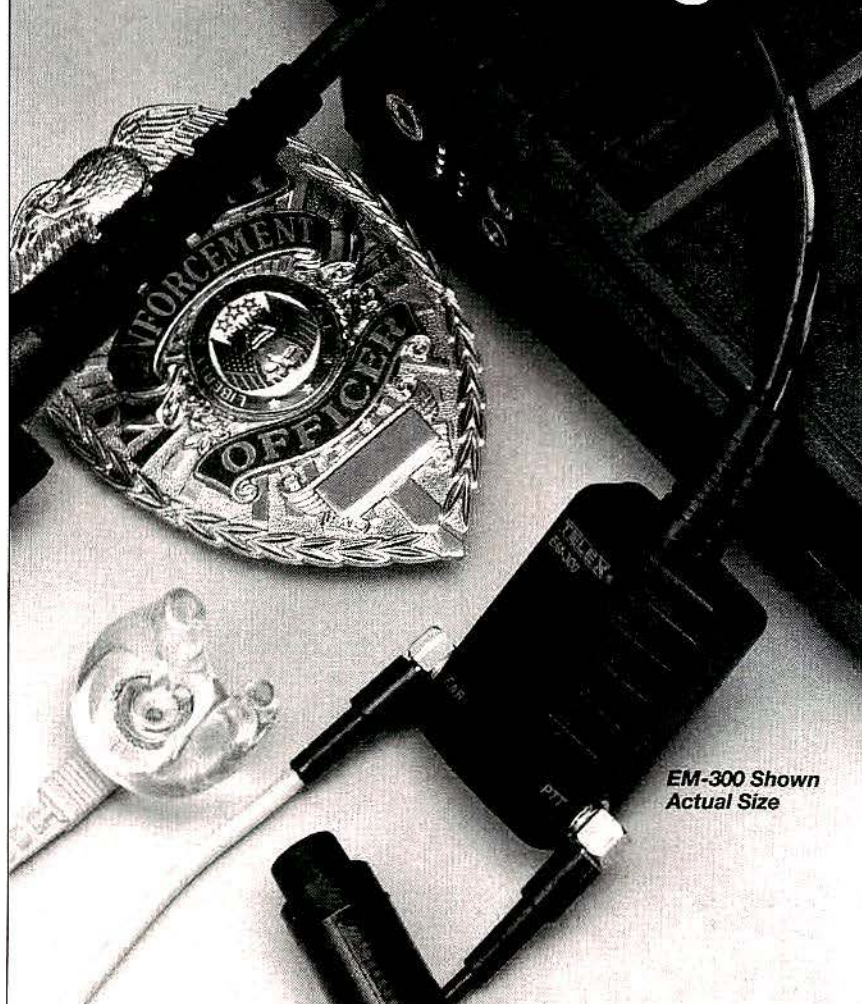
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Learn about FLASHport at the Motorola APCO Booth.

Circle (34) on Fast Fact Card



# Ear-Mike® With Hidden Advantages



**Telex EM-300**  
Reliable and Discreet

**NEW!** Our smallest Ear-Mike yet, the EM-300 delivers the performance you expect in a size that may surprise you. The easy to conceal unit is a discreet 1½" long, 1" wide and ½" thick. But it contains all the power you need for covert communications.

The EM-300 features an exclusive *signal shaping* circuit, which reverses loss in intelligence caused by digitally encrypted signals. And because it derives power from the portable radio, no batteries are required. The EM-300 may be purchased with a palm, ring or velcro push-to-talk switch for virtually hands-free operation.

Unlike our competitors' expensive "disposable" products, the EM-300 features removable PTT and ear cords, so in case of damage, you can replace *them* instead of the entire unit. The back panel also removes for easy servicing or replacement of radio cable.

You can depend on the EM-300 Ear-Mike for discreet communications. To find out more, contact Telex Communications, Inc., at 9600 Aldrich Ave. So., Minneapolis, MN 55420, (612) 887-5530.

©1992 Telex Communications, Inc.

**TELEX**

**APCO**

PacketCluster Systems (112)  
PacTel Teletrac (800)  
Penta (503, 505)  
Philips Electronics (502)  
Phonetix (1008)  
Plant Equipment (836)  
PolyPhaser (106, 107)  
Positron Industries (736)  
PRC Public Management Services (1028)  
Proctor & Associates (411)  
Promark (1014)  
Prototype (806)  
Public Safety Novelties (314)  
Public Safety Systems (415-425)  
Racal Recorders (110, 111)  
RAM Communications Consultants (1128B)  
RAM Mobile Data (1128A)  
Rescue 9-1-1 (Booth not assigned)  
Rohn (611)  
Sage Data Systems (743)  
Scala Electronics (1234)  
SCC (Systems Concept of Colorado) (728)  
Schlumberger Technologies (406, 408)  
Scientific Dimensions (634, 645)  
Sel-Tronics (339)  
Selectone (634)  
Setcom (1117)  
SFA (514)  
Shinwa (1010)  
Signal Communications (1222, 1224)  
Simrad (700)  
Skaggs Telecommunications Services (828-933)  
SMC Signal Measurement Company (1218, 1220)  
Solid State Communications (701, 703)  
Spectracom (910)  
Spilsbury Communications (742)  
SPJ Furniture Technology (1214)  
Stancil (601)  
Sti-Co Industries (1000)  
Stratus Computer (1016)  
Swagger Communications (1426)  
TCI (Tel Control, Inc.) (1101)  
TEAC America (509)  
Telex Communications (525)  
Telident (1002)  
Teltone (500)  
Telular (300, 302)  
Tiburon (623, 625)  
Times Microwave Systems (845)  
Tomar Electronics (1518)  
Tomba Communications (328)  
Tomcor (401)  
TPL Communications (108)  
Transcrypt International (1119)  
Transportation Safety Devices (400)  
TriCAD (1329, 1431)  
Trimble Navigation (518, 520)  
TRW Systems Integration Group (429-433)  
TSR Technologies (807)  
II Morrow (802)  
TWR Lighting (511)  
Tx Rx Systems (928)  
U.S. Commlink (1301)  
U.S. CommStruct (1004)  
U.S. Department of Energy (602, 604)  
Ultratec (1211)  
Unisys (1228)  
Valmont Industries (1011)  
Vega, A Mark IV Company (615)  
Volunteer Firemen's Insurance Serv. (1243)  
Waldmann Lighting (1342)  
Watson Furniture Systems (1106, 1108)  
Western Multiplex (601)  
Westinghouse Electric (1236, 1238)  
Whelen Engineering (1208, 1210)  
Zetron (1123, 1125)



# Have all those 2-Way Radio promises gone up in smoke?



## Know who you're working with.

*When I'm answering an alarm, I can't afford to have any doubts about my equipment. That's why I rely on my Kenwood 2-way radio and my "Team 2-Way" dealer to come through for me when the heat is on. They work with me to make sure I have a radio that meets the unique challenges of my job. Just like my Kenwood radio, my "Team 2-Way" dealer is there for me when I need it most. And that's a promise that comes through loud and clear.*

The TK-630, 730, 830 Series mobiles can be customized for many applications, including dual band and dual head configurations. And unlike other radios requiring expensive add-ons, the TK-630, 730, 830 Series come with these standard features:

- Built-in Public Address
- Backlit LCD and Buttons
- Assignable Buttons
- 12 Character Alphanumeric Capability
- Single or Dual Priority Scan
- Speaker Control
- Talk Around
- and many others...

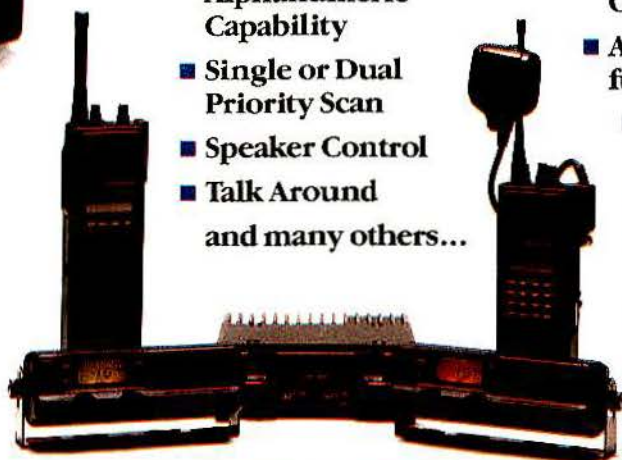
The TK-230SP and 330SP portables have been engineered to sustain the most rigorous demands of the public safety professional. These advanced generation VHF/UHF synthesized portables are produced with a rigid adherence to the highest quality control standards, and come with these standard features:

- Microprocessor Controlled Scan
- Synthesized 100-Channel Capability
- Alphanumeric, Multi-function LCD Display
- Built-in QT and Digital QT
- Five-Watt RF Output
- MIL-STD 810 Approved
- Wide Band Channel Frequency Spread

**We want  
you  
on our  
team!**

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DEALER DEMONSTRATION\*  
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\*While supplies last



**TEAM 2 WAY™**  
**KENWOOD**

Circle (36) on Fast Fact Card

P.O. Box 22745, Long Beach, CA 90801-5745 • (310) 639-4200 or fax (310) 761-8246

*We're committed to quality, service and value*



For more information on the products and services listed, fill out and return the Fast Fact Card on page 107. See sample below.

**FAST FACT CARD**

Circle number of product or service listed on page 107. (If you have more than one product or service listed, please fill out a separate card for each.)

1. Name of company or organization

2. Address

3. City

4. State

5. Zip

6. Telephone ( )

7. Fax ( )

8. E-mail

9. Product or service description

10. Other information

### XYZ Corporation Booth 7000

#### Existing services

Galaxywide paging, satellite rental, multilingual billing formats.

#### New Products

Coin-size pager. This unit operates on ambient heat and needs no batteries.

Circle 900

See ad page 310

## Products and services

Information listed was accurate at press time and is subject to change.

### 9-1-1 Magazine

Booth 105

#### Existing products

Publication for emergency communications and response.

Circle 250

### Alcatel Network Systems Booths 1328-1332

#### Existing products

Total transmission system solutions to meet communication needs. Capabilities include microwave radio, fiber-optics, digital cross-connects and network management capabilities.

Circle 251

### Alexander Batteries

Booth 607

#### Existing products

Replacement batteries and battery maintenance equipment for two-way radio, cellular phone and laptop computer industries. NiCd, sealed, lead-acid, alkaline, mercury and lithium batteries available.

Circle 252

### Allen Telecom Group

Booths 801-805

#### Existing products

Allen Telecom Group consists of Antenna Specialists and Decibel Products, which combine for nearly 100 years in the design and manufacture of RF communication equipment. Please refer to individual company listings for specific product information.

Circle 253

### Allgon Mobile

Booth 1216

#### Existing products

Mobile communications antennas including 450MHz, UHF, VHF, cellular, 800MHz and 900MHz trunking; glass mounts; permanent mounts; magnetic mounts; window clip; elevated feed trunk mounts; portables; marine.

#### New products

Clic 1138 series glass-mount cellular antenna; Kiss LM-8 series micro mag magnetic-mount antenna.

Circle 254

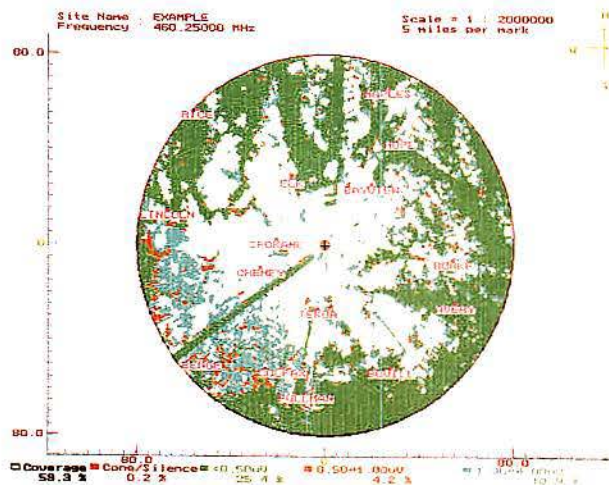
### Antenna Specialists

Booths 801-805

#### Existing products

Pro-5000 VHF and UHF mobile antenna line along with its cellular mobile series and dB Mobile brand of antennas; VHF and UHF base station antennas; ASP 977 Varitilt base antenna for

## RADIO ENGINEERING PRODUCTS



### "Everything you need for Site Development and FCC Applications"

#### SOFTWARE

3-D Terrain  
Coverage Predictions  
Fresnel Zone Studies  
Engineering Package  
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3 or 30 Second Terrain Files

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Coverage Predictions  
2-10 Mile H.A.A.T.  
Frequency Selection  
Topographical Profiles  
Intermod Study

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Phone: (904) 426-0014

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**C.E.T. INC.**

1001 S. Ridgewood Ave.  
Edgewater, FL 32132

Circle (37) on Fast Fact Card



# How can Bendix/King afford to offer a **5-year warranty?**



Simple.  
We make the industry's best-built radio.

We designed the EMV mobile UHF radio to elevated standards, then set our manufacturing and testing standards even higher. The result: total confidence. That's why we cover the EMV with the land mobile industry's best warranty: *five full years* at no additional charge.

The EMV's extruded housing, die-cast frame and surface-mount internal components afford extreme rigidity and resistance to vibration. Its rugged construction meets demanding MIL-SPECs 810 C, D and E.

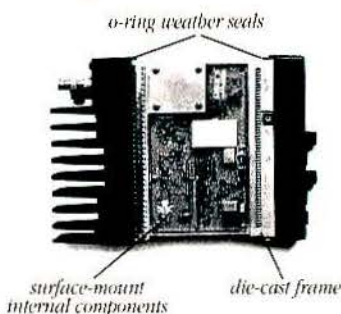
Extensive testing of components and circuits ensures reliability. *Every* unit withstands an 8-hour transmit/receive temperature-cycling burn-in test before acceptance as a finished product.

And we haven't sacrificed power, performance or flexibility. We've put features and options under high-performance digital control, written into system software, so there's never a need to open the case for adjustments.

The EMV's bright vacuum-fluorescent display shows easy-to-read alphanumeric characters. Power output is programmable from 10 to 40 watts. Programmable control buttons put a custom menu of functions at your fingertips. A 67-MHz bandwidth covers 403 - 470 MHz with no degradation in specification.

The EMV mobile offers advanced features for today and adaptability for the advances of tomorrow. And now, it carries *the industry's longest warranty.*

Because this is the industry's best-built radio.



## 1-800-648-0947

**BENDIX/KING**  
WORLD CLASS RADIOS™

2920 HASKELL AVENUE, LAWRENCE, KS 66046 • (913) 842-0402 • FAX (913) 841-0287

Circle (38) on Fast Fact Card

**AlliedSignal**  
AEROSPACE



trunking and cellular frequencies.

## New products

On-Glass IV cellular mobile antenna which features a solid-state coupling box that has eliminated all solder connections and is less than 1/2" thick. A hand-adjustable whip is available in either open or molded coil versions.

Circle 255

See ad IFC

## Armata Technologies

Booths 809, 811

## Existing services

System integration, communications design and

consultation, project management services and proprietary GPS-based automatic vehicle location products.

## New products

NavTrax GPS-based fleet management system that provides real-time vehicle positioning to accuracies of less than 5 meters.

Circle 256

## Avtec

Booths 617, 619

## Existing products

Color touchscreen integrated radiotelephone

console systems featuring one-touch control of telephone lines, conventional and trunked radio, paging and intercoms.

Circle 257

See ad page 58

## Bendix/King

Booths 909, 911

## Mobile Communications

## Existing products

VHF, UHF and 800MHz portables; VHF and UHF mobiles; dual transceiver mobile; signaling devices; accessories.

## New products

Standard five-year warranty (parts and labor) on the EMV 499 0A UHF mobile.

Circle 258

See ad page 43

## Cadex Electronics

Booth 709

## Existing products

C4000 4-station battery analyzer that services NiCd, NiMH and lead-acid batteries.

## New products

C3000 2-station battery analyzer for smaller battery user; CV1400 4-station fast-charger designed for vehicular applications.

Circle 259

## Cellular & Mobile International

## Existing products

Mobile Radio Technology and Cellular Business magazines jointly publish this bi-monthly magazine for the international marketplace. The publication, Cellular & Mobile International, focuses on key issues and developments pertinent to the mobile RF environment. The circulation of 10,000 predominantly reaches Africa, Australia, Central America, Europe, Far East, Middle East, New Zealand and South America.

Circle 260

## Cellular Business

Booth 508

## Existing products

Cellular Business is the "Journal of Cellular Telecommunications." It is published monthly and provides marketing and engineering information and news of the cellular industry. Readers are cellular professionals, including dealers; agents; resellers; engineers; and members of the telecommunications financial and legal communities.

Circle 261

## Celwave

Booths 808, 810

## Existing products

Base, mobile, portable antennas; receiver multicouplers; transmitter combiners; filter products; transmission line and connectors; bi-directional amplifiers.

## New products

SKD940-4H waveguide paging combiner; WJD860-5S waveguide trunking combiner; PD10183 10dBd omni antenna.

Circle 262

See ad page 21

## Centurion International

Booths 735, 737

## Existing products

Antennas and batteries for all types of communications equipment and specialized OEM applications.

## New products

EXP series of 2.5dB injection-molded trunking antennas.

Circle 264

See ad page 9

## CML Technologies

Booths 102-104

## Existing products

# SIEMENS

Siemens and the sun.  
Dependable power, anywhere.



In telecommunications systems of every sort, from highway emergency-phones used only intermittently, to radio and television stations broadcasting all day—you'll find Siemens solar modules providing continuous, dependable power.

High-efficiency and field-proven performance have made Siemens M-Series modules the leading choice for solar powered telecommunications installations.

For quality photovoltaic products, backed by a company that can give you the support you need, anywhere in the world, make the intelligent choice. Insist on Siemens.

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## Siemens Solar Industries

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One listen to our new SUMMIT™ series products will prove it. These are the highest spec Private Systems products in our 70 years in radio communications. It's also a clear sign of the new direction

# The Clearest Signal EF Johnson Has Ever Sent.

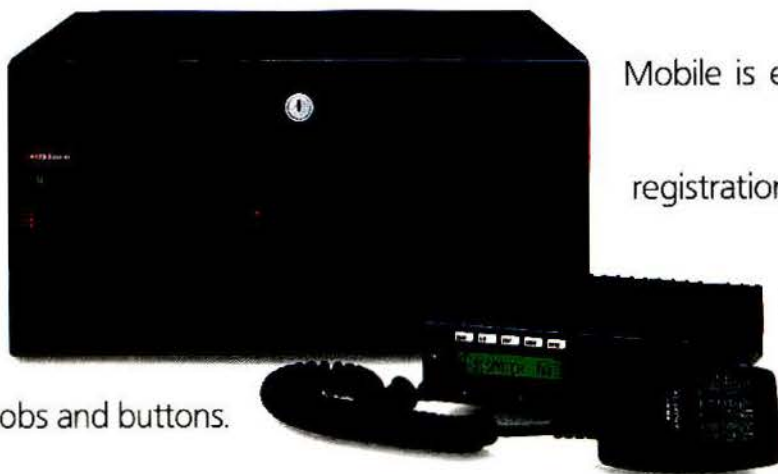
here at E.F. Johnson. For example, the new SUMMIT-QX Repeater is more powerful and reliable than anything we've ever offered. At just 8¾" in height, it allows you to add channels without adding rack

space. The SUMMIT-DM

with features like auto

unique UD²I™ interface,

user-friendly control knobs and buttons.



Mobile is equally advanced,

registration, encryption, our

and exceptionally

The SUMMIT

series products also provide a platform for migration to digital radio technology. Call us at

1-800-328-3911, ext. 6380 for our free brochure. If there's any confusion about where to find

the state-of-the-art in digital trunked radio, hearing the new SUMMIT series will clear it up.



© 1993 E.F. Johnson Company

Visit us at APCO, Booth #714.

Circle (40) on Fast Fact Card



Liberty mobile radio communications console system.

**New products**

Rescue STAR E9-1-1 system designed for smaller 9-1-1 applications; Liberty console which can be operated without the need for bulky back-room equipment.

Circle 265

**Coded**

**Booths 1314, 1315-1325**

**Communications**

**Existing products**

Wireless mobile data solutions; DXT mobile data terminal; automatic number identification equipment.

**New products**

CRT 1000 display solution; CMX 1000 mobile status and messaging data terminal; CMX 4500 mobile data terminal can send, receive and store messages and dispatches.

Circle 266

**Combined Technologies**

**Booth 1022**

**Existing products**

Smartswitch II remote comparator display used to monitor and control voting systems from a console or personal computer.

**New products**

Remote comparator display version 2.0 software includes voting system error logging.

Circle 267

**Communications Associates**

**Booth 711**

**Existing products**

IFR Communications service monitors and spectrum analyzers; Ericsson GE two-way radios; Helper Instruments test equipment; Andrew and Celwave coaxial cable and accessories; Mitsubishi Acces portable fax machine.

**New products**

IFR Com-120A service monitor; Ericsson GE Monogram series radios.

Circle 268

See ad page 20

**Communications**

**Booth 506**

**Data Services (CDS)**

**Existing services**

Real World Propagation services; CDS online and remote access services; USGS 3 arc second terrain data and land use; land coverage data on CD-ROM.

**New products**

RFCAD propagation prediction software for the PC; RFPATH point-to-point propagation analysis software for the PC; TPATH terrain analysis software for the PC.

Circle 269

**Dataradio**

**Booth 336A**

**Existing products**

VIS (vehicular information series) radio; modems and vehicular PCs; Texas Transportation Institute "Technocar 2000."

**New products**

Mobilmux intelligent mobile multiplexer.

Circle 270

**Decibel Products**

**Booths 801-805**

**Existing products**

Metal and fiberglass base station antennas; 800MHz and 900MHz site management equipment.

**New products**

Sentry remote site monitor system detects problems and displays alarms which may then be interrogated with the optional dB Host software for appropriate action.

Circle 271

See ad page 27

**Deltronics Communications**

**Booth 1043**

**Service**

**Existing services**

Perflex dispatcher pre-employment examination.

Circle 272

**DX Radio Systems**

**Booth 108**

**Existing products**

RTF series base station repeaters; DXP series paging transmitters.

**New products**

RTP series portable repeaters.

Circle 273

**E. F. Johnson**

**Booth 714-825**

**Existing products**

Mobile, hand-held and fixed-end equipment for LTR and Multi-Net trunking applications, including encryption, data and telemetry products.



## Custom Designed Dispatch & Control Centers

**Featuring:**

- CAD Design Techniques
- Welded Tubular Steel Framework
- Tough, Baked-On Epoxy Coating
- Color-Coordinated with New or Existing Decor
- Premium-Quality Laminates & Hardwood Trims
- Correct Ergonomics
- Superior Craftsmanship

STS designs and builds high-quality, custom dispatch centers for any application. Using advanced modular techniques for superior stability and longevity, along with premium materials, STS furniture is the best value in the industry.



Skaggs Telecommunications Service, Inc.  
5290 South Main • Salt Lake City, Utah 84107  
(801) 261-4400 • Toll Free: 800-879-1787

Circle (41) on Fast Fact Card



# Why Tinker Around When it Comes to Your Communications Testing.

RENT directly from IFR.  
Call 316/522-4981,  
Ext. 207 for details.



**Cellular...  
Trunking...  
Tracking Generator...  
now available with the *New FM/AM-1200S***

*The FM/AM-1200S is still the most feature intensive of all communications service monitors.*

**See for yourself.** The FM/AM-1200S includes a 1 GHz spectrum analyzer, 1 MHz scope, 2  $\mu$ V receiver, duplex capability, 150 watt power meter, RS-232 interface and numerous programmable functions—all standard in one self-contained, compact and portable unit. With **three new options**, the 1200S can now test cellular mobiles; CLEARCHANNEL LTR® compatible mobiles/bases; and duplexers, combiners and isolators.

Think of the advantages of having all these features in one package. With the 1200S cellular option you no longer have to be concerned with what type of test interface the radio has. By connecting a coax between the transceiver and test set you are ready to go. When you need to verify a trunked radio, just connect the RF cable, enter the mobile and system information into the 1200S and execute. This now eliminates the need for "add-on" or accessory units to perform cellular and trunked systems testing.

How many times have you wished for a convenient, inexpensive way to observe the frequency response of a cavity or duplexer? The new 1200S tracking generator option will do just that. By connecting two cables, you can observe the frequency response directly on the 1200S' CRT, providing for instantaneous monitoring of filter characteristics.

Where else can you get all this capability in one communications test set? No where! Compare and you'll agree...the FM/AM-1200S *is* the logical choice.

**Don't tinker around! Buy IFR, the monitors that make the others seem like toys.**

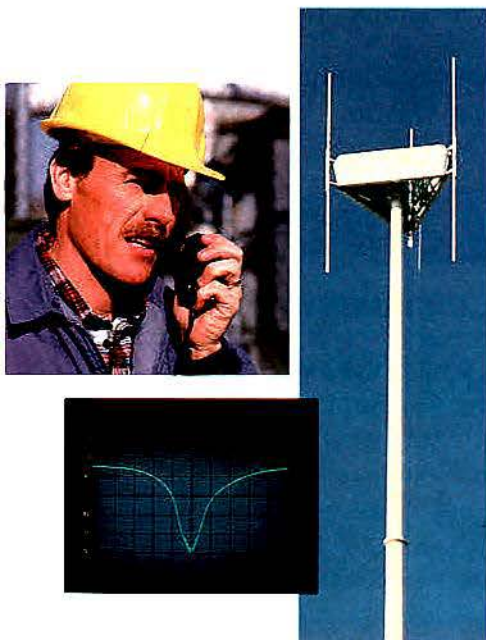
**IFR SYSTEMS, INC.** 10200 West York Street, Wichita, Kansas 67215-8935 U.S.A.,  
Phone 316/522-4981, TWX 910-741-6952, FAX 316/524-2623



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**USA**

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Circle (42) on Fast Fact Card





## APCO

### New products

Summit series of high-specification products including Summit DM mobile radio and Summit QX repeater.

Circle 274

See ad page 45

### ElectroCom

Booths 842-947

#### Communication Systems

##### Existing products

870 mobile data terminal; 890 mobile data computer; communication control console.

##### New products

Head up display.

Circle 275

### Emergency Information Services

Booth 1209

##### Existing products

Map-Dispatch complete CAD system with graphics for PCs.

##### New products

MapInfo geographic database analysis and display.

Circle 276

### Ericsson GE

Booth 614

#### Mobile Communications

##### Existing products

EDACS—Enhanced Digital Access Communications System with non-stop voice and data trunking.

##### New products

M-RK I and M-RK II portable radios; Orion mobile radio.

Circle 277

See ad page 23

### FailSafe Magnetics

Booth 1018

##### Existing products

24-hour audio logging tape—1" x 10 1/2" x 3,600' and 1/2" x 10 1/2" x 3,600'.

Circle 278

### Federal Signal

Booth 843

##### Existing products

Vision and Vector emergency warning light systems; SS2000 Smart Siren with BP100 compact speaker and other police vehicle "air-bag wise" equipment.

Circle 279

### Flash Technology

Booth 1311

##### Existing products

FTB 310 and FTB 311 aviation strobe obstruction lighting.

Circle 280

See ad page 85

### Gamber-Johnson

Booths 902, 904

##### Existing products

Slide mounts, Floor Master radio mount system, MDT and computer mounts; docking stations for laptop computers.

##### New products

Mission Control System of air bag-friendly mounting hardware; MCS-Bases; MCS-Heads; MCS-Consoles; MCS-Racks.

Circle 281

See ad page 50

### GTE Government

Booth 414

#### Information Services

##### Existing products

Integrated Emergency System (IES) for public safety including Enhanced 9-1-1; computer-aided dispatch; police, fire and emergency medical service information management systems; geographic information systems.

Circle 282

### Harris

Booths 528, 530, 629, 631

#### Farinon Division

##### Existing products

DVM 6-45 radio.

##### New products

DVM 6-12T radio; HINT network management program.

Circle 283

### HBF Goup

Booth 1200, 1202

##### Existing products

System-9 E9-1-1 software and systems integration.

Circle 284

### Hewlett-Packard

Booth 600

##### Existing products

HP 8920A RF communications test set is a portable service monitor with more than 22 functions to find problems faster—includes a high-performance spectrum analyzer and software for testing cellular radios.

Circle 285

See ad page 18

## Call on Maxon.

For nearly two decades, law enforcement agencies and public safety organizations have trusted Maxon FM two-way radios with their routine and emergency communications.

We offer a complete line of synthesized hand portables, mobiles and 800 MHz trunked radios, featuring rugged case materials and user-friendly controls.

Numerous accessories and signalling options are available for each Maxon radio, adding versatility and flexibility in use.

For dependable two-way communication...

Call on Maxon.

# maxon®

## A World of Communications

### Business Radio Division

10828 NW Air World Drive • Kansas City, Missouri 64153

816/891-6320, ext. 606 • Fax: 816/891-8815

Circle (43) on Fast Fact Card

Let's discuss your communication needs!  
Visit MAXON at APCO Booth #507



**Inset:** The SP-2000 Series Radio is tested and approved to MIL-STD 810 D and E for ruggedness and operation under harsh conditions. SP-2000 Series shown with optional DTMF keypad and speaker/mic.



# POWER ON... with ASTRON.

Astron Corporation is the leading manufacturer of high-quality power supplies and converters for the land mobile industry.

With the new SL-11 series of low profile power supplies, specifically designed for base station applications, the setup is simple, easy and looks attractive. Just mount the radio, with the mounting pads (supplied with the power supply), to the top of the SL-11A (2 3/4" H x 7 5/8" W x 9 3/4" D) or the SL-11R (2 3/4" H x 7" W x 9 3/4" D). The power supplies are very well regulated and will provide 11 amps of current at a 50% duty cycle. The units have fold-back current limiting to protect them from overload and short circuit, and an overvoltage protection feature to protect the radio should the output voltage exceed a safe level. All SL series units are available in dark gray or black.

Power supplies and converters from Astron: our unsurpassed quality and reliability have made us the #1 choice in the communications industry.



SL-11R (black)



SL-11R (dark gray)



**ASTRON** SL-11A

**ASTRON**  
CORPORATION

9 Autry, Irvine, CA 92718  
Telephone: 714/458-7277  
Facsimile: 714/458-0826



## Hughey & Phillips

Booth 1115

### Existing products

FAA-approved obstruction lighting, controllers and monitors for tall towers.

### New products

Dual lighting control model No. 9LCE233LORAS.  
Circle 286

## IFR Systems

Booth 510

### Existing products

Communications service monitors and spectrum analyzers, including the COM-120A and AN-930 microwave spectrum analyzer.  
Circle 287

See ad page 47

## Intergraph

Booth 428

### Existing products

Dispatch management system—computer-aided dispatching.  
Circle 288

## Kenwood Communications

Booth 436

### Existing products

VHF and UHF portables, mobiles, base stations and repeaters; trunked portables, mobiles and repeaters; 30 series multi-configurable mobiles; dash, single head, dual head, dualband.

### New products

TKR-9300S 800MHz trunked repeater systems; TK-430 800MHz 16 system, 2.5W trunked portable; TK-431 900MHz 16 system, 2.5W trunked portable.  
Circle 289

See ad page 41

## Magnasync-Comverse

Booths 708, 710

### Existing products

DVL 1000 digital voice logger—a computer automated digital logger that combines telemanagement software with voice recording and archives recording on either optical disk or 8mm tape. The Specialist is an advanced microprocessor-controlled, multi-channel recorder that satisfies the highest reel-to-reel requirements.  
Circle 290

## MaSys

Booth 1009

### Existing products

Enfors computer-aided dispatch system.  
Circle 291

## Maxon America

Booth 507

### Existing products

SP-2000 synthesized UHF and VHF portable radio; SM-4000 series synthesized mobile radios; CP-0500 crystal portable radio.

### New products

TP-4800 800MHz trunking radio; SL-500 99-channel scanning portable radio; SND series numeric display pagers.  
Circle 292

See ad page 48

## Maxrad

Booths 1109, 1111

### Existing products

Land mobile, base station and cellular antennas; related accessory products.

### New products

MYG series yagi antennas; MEFHD series

heavy-duty elevated feed antennas; MMA series marine antennas.

Circle 293

See ad page 25

## Metroplex Mobile Data

Booth 739

### Existing products

Mobile data systems including RF modems, laptop computers, portable RF modem, hand-held computers, complete hardware and software system integration to CAD, records management, external databases (state crime info, national crime info, etc.); manufacturing design and installation of complete turnkey systems.  
Circle 294

## Microwave Radio

Booth 536

### Existing products

MR-23VX-LAN 23GHz digital microwave radio.

### New products

MR-22DR 23GHz digital microwave radio.  
Circle 295

## Midland Land Mobile Radio

Booth 1308

### Existing products

Syn-Tech XTR mobile radios and desktop stations with built-in modem option; Base-Tech repeaters and dispatch stations; trunking mobile radio for VHF, UHF and 800MHz bands; portable radio series.

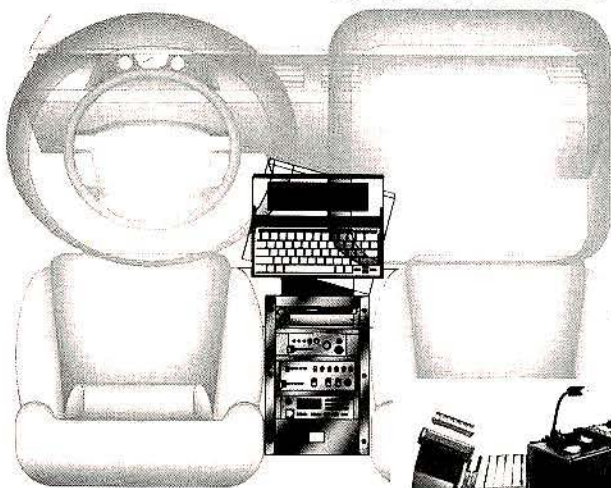
### New products

Syn-Tech XTR mobile and portable radios capable of conventional or trunking operation in

# NOW

A Complete Air Bag Friendly™ MOUNTING SYSTEM for Your Voice & Data Mobile Communications Equipment

# MissionControl™



Modular components let you assemble the configuration you need - outside the air bag deployment zone.

Install the MCS-BASE and build your system - without drilling into the vehicle floor. Choose from a variety of combinations:

- **Console or Racks** Hold up to 5 radios, control heads, siren/light controllers, etc.
- **Mount Heads** For MDT's and laptop/notebook computers.
- **Accessories** Map light, adjustable cup holder, power distribution package.

### Compatible with barriers and vertical gun racks

Available for Chevrolet Caprice & Lumina Sedan, and Ford Crown Victoria & Taurus

Get complete information now.

Call 1-800-GJ-Mount (1-800-456-6868)

FAX 1-800-WE-HELPP (1-800-934-3577)

## GAMBER-JOHNSON

Service & Solutions™

801 Francis Street, Stevens Point, Wisconsin 54481



Be in control - for every mission!

Circle (45) on Fast Fact Card



# Who Makes The Smallest Intrinsically Safe Portable? ICOM!

**IC-H28**  
VHF Transceiver

**IC-U28**  
UHF Transceiver

ICOM presents the smallest Intrinsically Safe portable tough enough for use in industrial environments—without sacrificing functionality.

Small size by itself is no benefit if you can't see or use the controls in real life. We made the U28/H28 small on the outside, but the controls are big and the functions accessible, even with gloves on.

The U28/H28 has the full Factory Mutual IS rating, and meets MIL 810C/D specifications. We put in the safety and ruggedness industrial users need.

- Full 5w power when you need it
- 1 or 2w for extra battery life
- Weather, dust and atmosphere-resistant case
- 16 fully programmable channels
- Full bandwidth operation
- PC programmable
- 2 internal expansion slots
- Optional DTMF keyboard
- Optional speaker/microphone
- Optional encoder units

For more  
information call

**1-800-426-7983**

ICOM America, Inc., 2380-116th Ave. N.E.  
Bellevue, WA 98004

All stated specifications are subject to change without notice or obligation. All ICOM radios significantly exceed FCC regulations limiting spurious emissions. U28593

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Circle (46) on Fast Fact Card



# ICOM



VHF and UHF bands; LTR trunking compatible radios.

Circle 296

See ad page 57

## Mobile Data Communications Booth 704

### Existing products

MobileMap, FireMap, FireCommand application software.

### New products

MDC-386i in-vehicle PC; multi-incident fire command application software.

Circle 297

## Mobile Mark

### Existing products

Vehicular antennas for cellular, trunking and two-way applications; On-Window antennas with the carwash-proof 3dB whip; RM series roof mounts with the quick disconnect for whip and the spring-loaded center pin; clip-on portables with TNC, Mini-U or Electro-Coupler connection; Mini-Mag mount antennas with low-profile, rugged base; high-performance corner reflector; dual-helix base station antennas.

### New products

Booths 1100, 1102

DH14-2000 base station antenna for 1.8GHz-2.5GHz; OW450 and OW800 On-Window cellular, two-way dualband antennas; RFFO-900 unity gain roof-mount antenna with rubber duck-style whip; several Clip-On Coupler antennas for additional portable cellular phone models.

Circle 298

See ad page 32

## Mobile Radio Technology

Booth 508

### Existing products

Written to keep industry professionals up to date on the latest in equipment, technology, techniques, business developments, legal and regulatory matters, *MRT* is recognized as the leading source of technology-oriented industry guidance. Visit our booth to pick up a copy and sign up for your free subscription.

Circle 299

## MX-Com

Booths 543, 545

### Existing products

Pvt Squelch privacy adapters and Cypher-MX VSB scramblers for two-way radios; CADi computer-aided dispatch modules for PC-based channel management.

### New products

MX P1281 Cypher-MX VSB scrambler adds high security scrambling to your two-way radio.

Circle 300

See ad page 7

## NEC America

Booth 707

### Existing products

21GTX network management system to monitor and control radio, fiber-optic and cellular networks.

Circle 301

## Northern Technologies

Booth 1242

### Existing products

Power protection systems including ac, phone and data lines.

### New products

19" rack-mount surge suppressor using silicon avalanche diodes.

Circle 302

## O A R

Booth 1001

### Existing products

.5MHz-1,300MHz automatic radio DF systems.

### New products

HH 1307 hand-held DF system.

Circle 303

## Orbacom Systems

Booths 606-610

### Existing products

TDM-150 series distributed micro-processor consoles; Calida + console.

### New products

TDM-150 video enhanced telecommunications access and control console.

Circle 304

## PacketCluster Systems

Booth 112

### Existing products

Complete mobile data communications system with automatic vehicle location.

### New products

Automatic vehicle location.

Circle 305

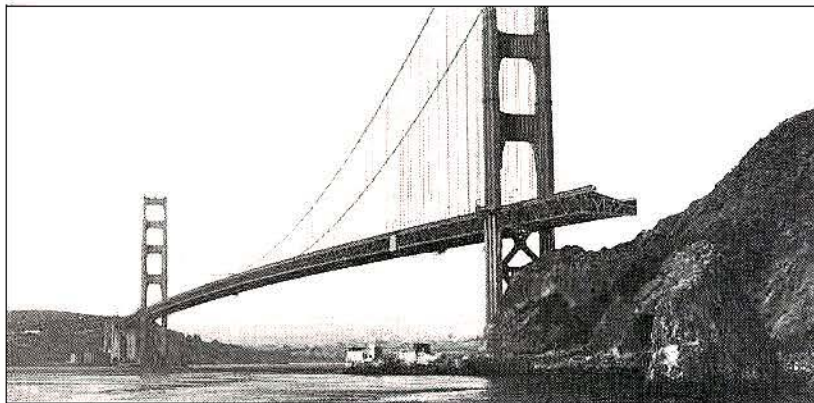
## Penta

Booths 503, 505

### Existing products

PCX communications control system; Touchscreen and mouse-controlled dispatch con-

# You could hire several companies to complete one important project.



# But that idea falls short.

At JEFA International, we provide *turnkey* voice, data and video communications systems worldwide. From beginning to end, each project is planned, directed and integrated by our own team. So you're never left hanging.

One call. One team. One solution.

**JEFA** INTERNATIONAL, INC.  
Telecommunications Services  
214/424-5680

**The word is out.**

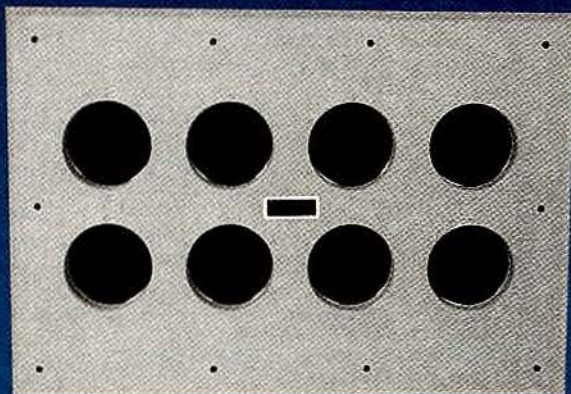


# MORE or LESS



## *PolyPhaser's Bulkhead System*

Compare PolyPhaser's Bulkhead coax cable entry system to the standard entry panel and the logical choice based on features, function and price is the Bulkhead System. 3,5,8,10,16 & 24 ports stocked. UPS shippable.



## *Standard Entry Panel*

### *Compare our features:*

- Multi-port panel of structural 1/8" copper
- Entry boots - one size fits all to 3-1/8"
- Built-in weatherized grounding kits
- Easy fit for 16"o.c. studs (no framing needed)
- 30% lower overall cost than standard entry panels

### *Compare functions:*

- Low inductance grounding for lightning protection
- Low inductance coax protector mounting
- Universal protector mounting plates
- Weather/corrosion proof conductive joint compound
- Copper cleaning kit
- 10 year warranty

*There is no comparison - so why pay more for less!*

**K PolyPhaser**  
CORPORATION ®

1500 models of coax, power and twisted pair protectors ...  
plus lightning/EMP and grounding solutions.

(800) 325-7170 ■ (702) 782-2511 ■ FAX: (702) 782-4476  
2225 Park Place ■ P.O. Box 9000 ■ Minden, NV 89423-9000

Circle (48) on Fast Fact Card



soles; PC3 base station controller; Pentacom 2000 emergency console system.  
**Circle 306**

# **PolyPhaser** **Booths 106, 107**

**Existing products**  
Grounding and lightning arrestor products for coax (dc-18GHz); twisted pair (Telco or data); ac and dc power.

**New products**  
Model 58R-112S ground clamp; model 20C-112S ground clamp; model MSC-3 ground clamp; model IC-112S ground clamp; CCR copper cleaning kit; IS-IEML50LN isolated microwave coax protector.  
**Circle 307** **See ad page 53**

# **Positron Industries** **Booth 736**

**Existing products**  
E9-1-1 emergency systems and products; Express, a telecommunications device for the deaf; TRCC telephone and radio communications console.

**New products**  
EL display—electro-luminescent display.  
**Circle 308** **See ad page 73**

# **PRC** **Booth 1028**

**Existing products**  
COBOL computer-aided dispatch system (CAD) on DEC VAX machine; Oracle/Trifox records management system (RMS) on DEC VAX machine; demonstrations of various PRC interfaces

with the following vendors: Trimble Global Positioning System (GPS), Motorola mobile data terminals, Zetron station alerting (models 25 and 26), Choral (EMS hospital status update information), Hughes' Heads-up display.

**New products**  
Altaris includes graphical user interface (GUI), CAD and records management systems on the various systems/hardware: IBM PCs, Hewlett-Packard, Digital-Alpha.  
**Circle 309**

# **Promark** **Booth 1014**

**Existing products**  
Rhubot classic; Rhobot QA; Rhobot win; Rhobot client server.  
**Circle 310**

# **Prototype** **Booth 806**

**Existing products**  
CMS/PC—a PC-based computer software package which manages and tracks maintenance for communications, radio and electronic equipment.  
**Circle 311**

# **Public Safety Systems Incorporated (PSSI)** **Booths 415-425**

**Existing products**  
Computer-aided dispatching (CAD) system.  
**Circle 312**

# **RAM Mobile Data** **Booth 1128A**

**Existing products**

Public safety systems integration for mobile data oriented CAD dispatch; automatic vehicle location and geographic information systems (AVL/GIS); records management systems (RMS); Origin technology in business; systems integrator for public safety wireless imaging and information management systems.

**Circle 313**

# **Rohn** **Booth 611**

**Existing products**  
Guyed towers, self supporting towers, steel poles, tower obstruction lighting, concrete equipment shelters, fiberglass equipment shelters, fiberglass cabinets.

**New products**  
Concrete pole, fiberglass pole.  
**Circle 314**

# **Sage Data Systems** **Booth 743**

**Existing products**  
CSERVICE service management system, designed specifically for communications service facilities.  
**Circle 315**

# **Scala Electronics** **Booth 1234**

**Existing products**  
Fixed-station antennas for 800MHz and 900MHz trunking, paging, telemetry, point-to-point and two-way communications.  
**New products**

RESONANT  
CAVITY

## **FILTERS AND DUPLEXERS**

IN RANGES FROM:

**30 MHz - 960 MHz**

IN RANGES FROM:

**30 MHz - 1.3 GHz**

**VARI-NOTCH® BANDPASS**



Our bandpass, Series-Notch®, Vari-Notch® and combine resonant cavity filters have demonstrated long-term reliability and high performance in the toughest commercial radio sites in the world. From single-channel repeater sites to advanced multicoupler systems, our superior filter quality makes a difference.



**SERIES-NOTCH®**

**NOTCH**



**60**

**PUBLISHED  
MODELS**



With silver-plated resonator parts and heavy-gauge, heliarc-welded end caps,

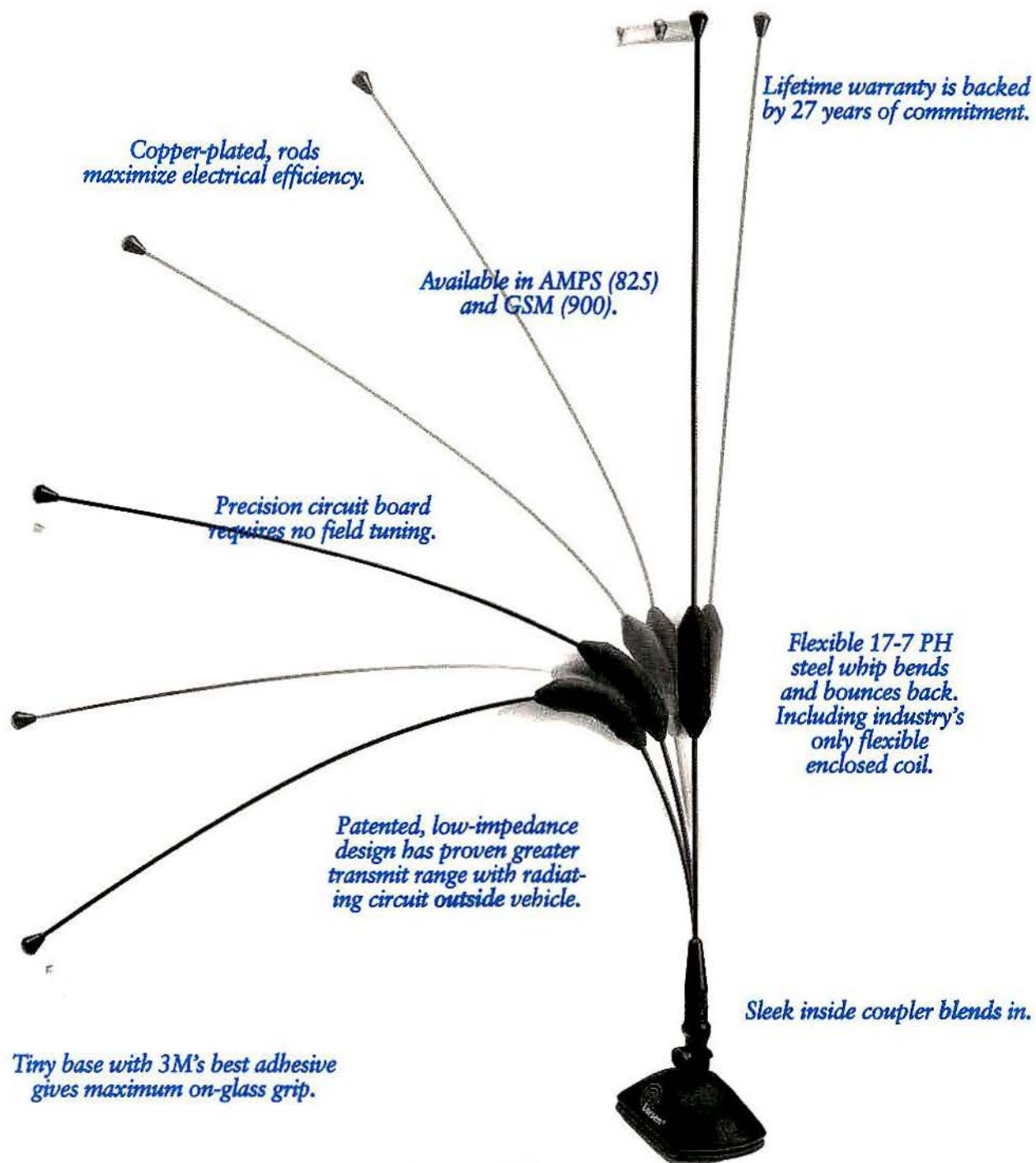
our cavity and combine filters produce exceptional duplexer performance: 100 dB isolation at 240 KHz separation in the VHF range; 100 dB UHF isolation at 5 MHz separation with four 4" cavities; Wideband VHF, UHF, 800 MHz and GSM duplexers for trunking and radiotelephone system applications.



**MULTICOUPLER SYSTEMS • SIGNAL BOOSTER SYSTEMS • DUPLEXERS • CAVITY FILTERS • RF SYSTEM PRODUCTS**

**TX RX SYSTEMS INC. 8625 INDUSTRIAL PARKWAY, ANGOLA, NY 14006  
TELEPHONE 716-549-4700 FAX 716-549-4772 [24 HRS.]**





# No Other On-Glass Antenna Stands Up To Larsen.

**1<sup>st</sup> WORLD'S  
BEST  
ON-GLASS  
ANTENNAS**

For on-glass antennas, Larsen's state-of-the-art features set industry standards. They maximize cell system performance. Increase voice quality. Prevent

dropped calls. And of course, make happy subscribers.

So call 800-426-1656 or fax 206-944-7556.

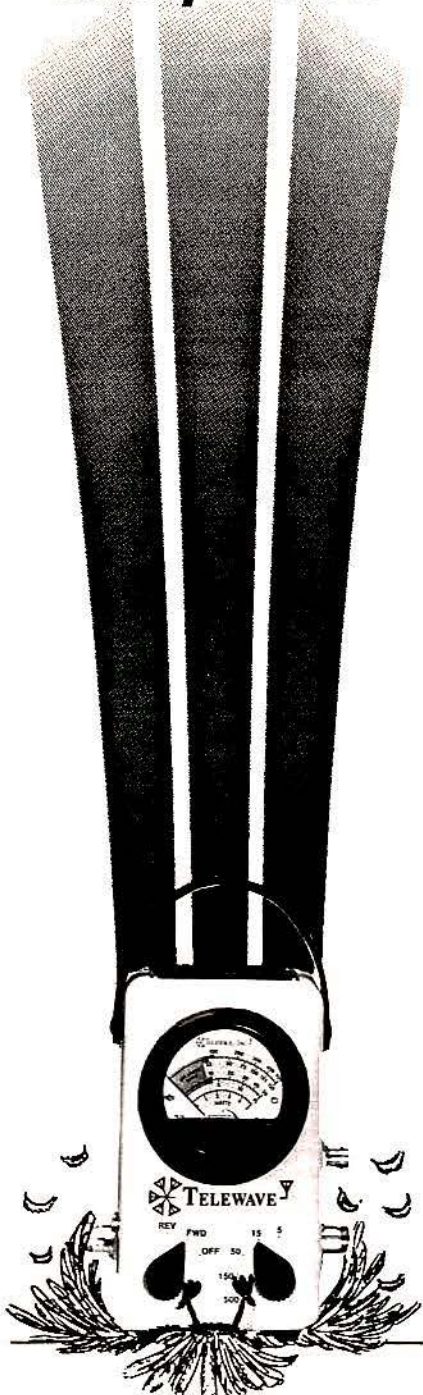


**Larsen Antennas®**  
The Clear Choice™

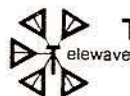
Circle (50) on Fast Fact Card



# Telewave's Broadband RF Wattmeter is rapidly becoming a new Industry Standard!



## We're Crushing the Competition!



Telewave, Inc.



## APCO

Americell panel antennas; 220MHz fixed-station antennas.  
**Circle 316**

**SCC Booth 728**  
*Existing products*  
Premier computer-aided dispatch (CAD); Premier graphic geofile manager (GGM); Premier universal data transfer (UDT); Premier tactical map display (TMD).  
**Circle 317**

**Schlumberger Technologies Booths 406, 408**  
*Existing products*  
4031S radio test set; 4015S radio test set; 7780-OTDR.  
*New products*  
4015S-EDACS trunking radio test set.  
**Circle 318 See ad page 63**

**Selectone Booth 634**  
*Existing products*  
ST/25/26 voice encryption modules; data messenger system; tone signaling boards (CTCSS, DTMF); ANI encoders and decoders.  
**Circle 319 See ad page 3**

**Setcom Booth 1117**  
*Existing products*  
Headset, helmet com-kits and face mask com-kits (SCBA) for use with both portable and mobile radios.  
*New products*  
Fire apparatus intercom/radio mixer systems.  
**Circle 320**

**Signal Communications Booths 1222, 1224**  
*Existing products*  
Mark II and Mark III radio alarm receiving consoles; rapid response fire dispatch; 8 MTJ-A radio fire alarm box; user-powered radio alarm box.  
**Circle 321**

**SMC Signal Measurement Company Booths 1218, 1220**  
*Existing products*  
Easy installation hardware for communications equipment.  
*New products*  
ALP-SM low-profile rack system designed to fit under the air bag zone; redesigned console units; Sprint SCADA controllers.  
**Circle 322**

**Skaggs Booths 828-933**  
**Telecommunications Service**  
*Existing products*  
Electronic console furniture; special purpose vehicles including a specialized security van.  
*New products*  
An in-car video system installed in a patrol car.  
**Circle 323 See ad page 46**

**Spectracom Booth 910**  
*Existing products*  
Netclock/2 NIST synchronized clock; 8176 large display clock.  
**Circle 324**

**Stancil Booth 601**  
*Existing products*  
DBR series VHS logging recorders; IR series solid-state instant recall.

*New products*  
Minicom IV software programmable console.  
**Circle 325**

**Sti-Co Industries Booth 1000**  
*Existing products*  
Disguised mobile two-way antennas, including custom fender-mount lowband, highband, UHF and broadband models; cellular look-alike VHF and UHF antennas; low profile transit antennas in highband, UHF, 800MHz and 900MHz frequencies; special use antennas; couplers; tuners; dual-matched systems.  
*New products*  
Disguised cellular look-alike antennas that are both dualband and broadband; EF-150/450 covers 24MHz bandwidth in VHF and 20MHz bandwidth in UHF; EF-450/800 covers 15MHz bandwidth in UHF and 60MHz in cellular; elevated feed style cellular replicas are available in roof and trunk lip mounts; custom fender-mount disguised antennas for 1993 models; Plymouth Concord, Dodge Intrepid and Jeep/Eagle Vision (model CIV); Eagle Talon (CTA); Jeep/Eagle Grand Cherokee (CGC); Chevy Camaro and Pontiac Firebird (GCA); Ford Probe (FPB); and Mercury Villager (FMV)—available in lowband, highband, UHF and broadband.  
**Circle 326 See ad page 66**

**TEAC America Booth 509**  
*Existing products*  
Voice logging recorders incorporate the latest design in VHS linear voice recording: 24-hour recording on a single VHS tape, modular design with access to all internal components from front panel; complete programmability from front panel.  
**Circle 327**

**Teltone Booth 500**  
*Existing products*  
9-1-1 switched access system; TLS-4 telephone line simulator.  
*New products*  
Trunk monitor unit (TMN-A-01).  
**Circle 328**

**Telular Booths 300, 302**  
*Existing products*  
Fixed cellular products.  
*New products*  
PCS<sup>one</sup> and PhoneCell CPX.  
**Circle 329**

**Tomba Communications Booth 328**  
*Existing products*  
Motorola two-way radios; Motorola Radius two-way radios; CCTV—EMS telemetry.  
*New products*  
APCOR cellular transmitters; Motorola MTX8000 portables; Motorola portable repeaters.  
**Circle 330**

**Transcript International Booth 1119**  
*Existing products*  
Crypto Voice Plus (CVP) family of scramblers combine the best of analog and digital voice privacy systems.  
*New products*  
CVP-S<sup>2</sup> (SC-20-480) system scrambler with continuous synchronization.  
**Circle 331 See ad page 5**



# Midland strikes again!

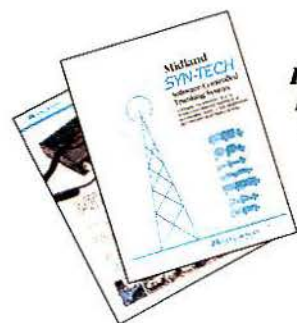


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## Trimble Navigation Booths 518, 520

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## TSR Technologies Booth 807

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**Circle 333**

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**Circle 334**

## Tx Rx Systems Booth 928

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**Circle 335** See ad page 54

## Valmont Industries Booth 1011

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**Circle 336**

## Vega Signaling Products Booth 615

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**Circle 337** See ad page 1

## Watson Booths 1106, 1108

*Furniture Systems*  
*Existing products*  
Basik 4 ergonomic dispatch consoles.

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Adjustable Flex III calltaking consoles; Sitag ergonomic seating.  
**Circle 338**

## Whelen Engineering Booths 1208, 1210

*Existing products*  
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*New products*  
Omni alert siren system; WS-29SHF automatic siren (hands free).  
**Circle 339**

## Zetron Booths 1123, 1125

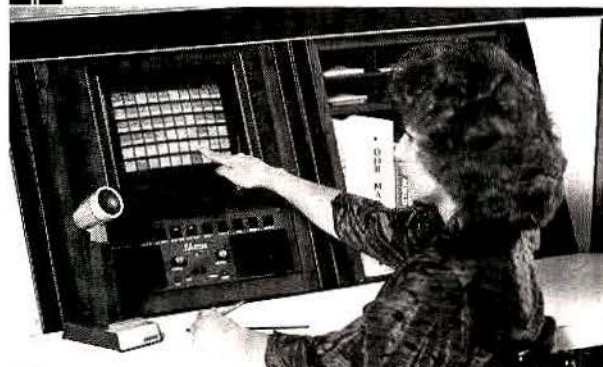
*Existing products*  
Radio console systems, dispatch consoles, modular dispatch and PSAP products, fire station alerting systems, instant-recall message recorders.

*New products*  
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**Circle 340** See ad page 67



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# Troubleshooting methods for the radio installer

*Installers can use fundamental techniques to troubleshoot mobile radio problems. The results may be speedier service to customers and an opportunity for the installer to become a service technician.*

By Terry W. Ellis

Simple troubleshooting skills can be useful to installers who may be in a position to offer speedier service to customers.

When all the repair technicians in a service center are busy, an installer may be asked to check out a mobile radio. Knowing how to apply basic skills can help an installer who wants to qualify for service assignments.

Technicians who are new to radio maintenance can solve many equipment problems by applying fundamental techniques. Even the most highly trained service technician starts troubleshooting by checking the simplest possible faults first.

## Listen to the customer

If the customer is present to tell you what is not working properly with the radio, take time to listen. Then check to see whether the radio fails to perform in the way the customer describes.

Some quick, routine inspections and

test procedures can eliminate a number of simple possible faults.

Look for the antenna to make sure there is one. Observe whether it appears to be in working condition.

In the vehicle, see that the radio is on the proper channel.

Then check for squelch noise. Reduce the squelch to minimum, and turn off the tone squelch feature or place the unit in monitor mode and remove the microphone from its hanger. Removing the microphone from its hanger breaks a ground circuit that opens the squelch when the radio is in monitor mode. This procedure verifies whether the audio, speaker and squelch are working. Tone squelch often is known by manufacturer trademarks such as Private Line and Channel Guard.

Grasp the control cable behind the control head and move it about to see whether audio from the speaker stops intermittently or altogether, indicating a problem with the cable or its connection.

In some of the tests that follow, the transmitter will be keyed. For safety, be sure to unkey the transmitter before handling the antenna and its connections, and make sure no one else comes in contact with them when the transmitter

is keyed.

At most mobile radio power levels, there is little danger of electrical shock, but it is good practice to observe safe procedures, as well as monitoring the channel to avoid transmitting when it is busy and giving station identification.

Key the transmitter (press the microphone button) and see whether the squelch noise stops and the transmitter light comes on. If the radio communicates through a repeater, notice whether keying the transmitter activates the repeater.

If the repeater has been activated, the squelch noise will be quieted for one to six seconds after you release the button. The busy light will come on during this period. This procedure verifies whether the radio is switching from receive to transmit when the button is pressed and whether it is transmitting and receiving, at least minimally.

As you listen to the channel on a service monitor or on a scanner with an earplug, transmit again while speaking into the microphone and notice whether the modulation breaks up when you wiggle the microphone cable. If so, replace the microphone cord and try again.

Connect a wattmeter between the radio and the antenna, key the transmitter and measure the transmitter power output with the wattmeter set to read forward power. Under normal conditions, the wattmeter will read the rated power output.

Unkey the transmitter, set the wattmeter to read reflected power, and key the transmitter once again. If the antenna is working properly, the reflected power will be no greater than 10% of the forward power.

Ellis is a radio technician with City/County Communications, Spartanburg, SC.

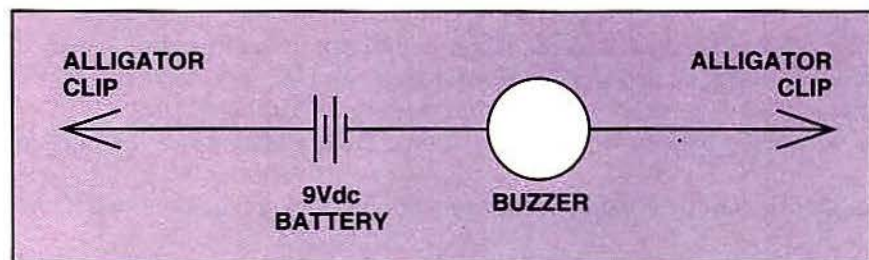


Figure 1. Check the antenna cable continuity using a tester configured as shown.





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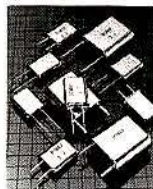
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## Quick checklist

### I. Antenna.

A. Check to see it is in place and looks tightly mounted and undamaged.

B. Check to see that the mount is tight and that the shock-spring wire is unbroken, if the antenna has such a wire.

### II. Control head.

A. Check for proper channel.

B. Check for audio in the form of squelch noise. Turn the tone squelch off; set the monitor switch for noise; take the microphone off its hanger and be sure the microphone is not grounded; and start the vehicle engine in case the radio power is wired to the ignition side of the switch.

C. Move the volume and squelch controls up or down, and jiggle the cable behind the control head to check for intermittent problems. Key the transmitter, speak into the microphone and jiggle the control and microphone cables while listening to the transmitter channel on a service monitor or scanner for interruptions in the modulation. Monitor the channel before transmitting, and use station identification when transmitting.

D. Key the radio, listen for receiver muting and squelch quieting, and see whether the transmitter light comes on. If the radio is on a repeater system, the radio's busy light should illuminate when you unkey the radio. It will light for one to six seconds. The squelch should be off for the same length of time.

E. If the results of these tests are satisfactory and the radio still does not work, see the article text under "receiver."

### III. No transmit or poor transmit.

A. Check the radio using a wattmeter.

B. Check all the fuses with a continuity tester.

C. Check all the ground connections.

D. Check the antenna cable for an open circuit with the continuity tester.

### IV. Antenna.

A. Measure forward and reflected power. If both are about half the rated power for the transmitter, check the antenna cable for a short-circuit using the continuity tester.

B. If the antenna cable is not shorted and the wattmeter still shows excessive reflected power (more than 10% of the forward power), adjust the antenna according to the antenna cutting chart to reduce the reflected power to an acceptable level.

V. Have a licensed or certified technician check the work.



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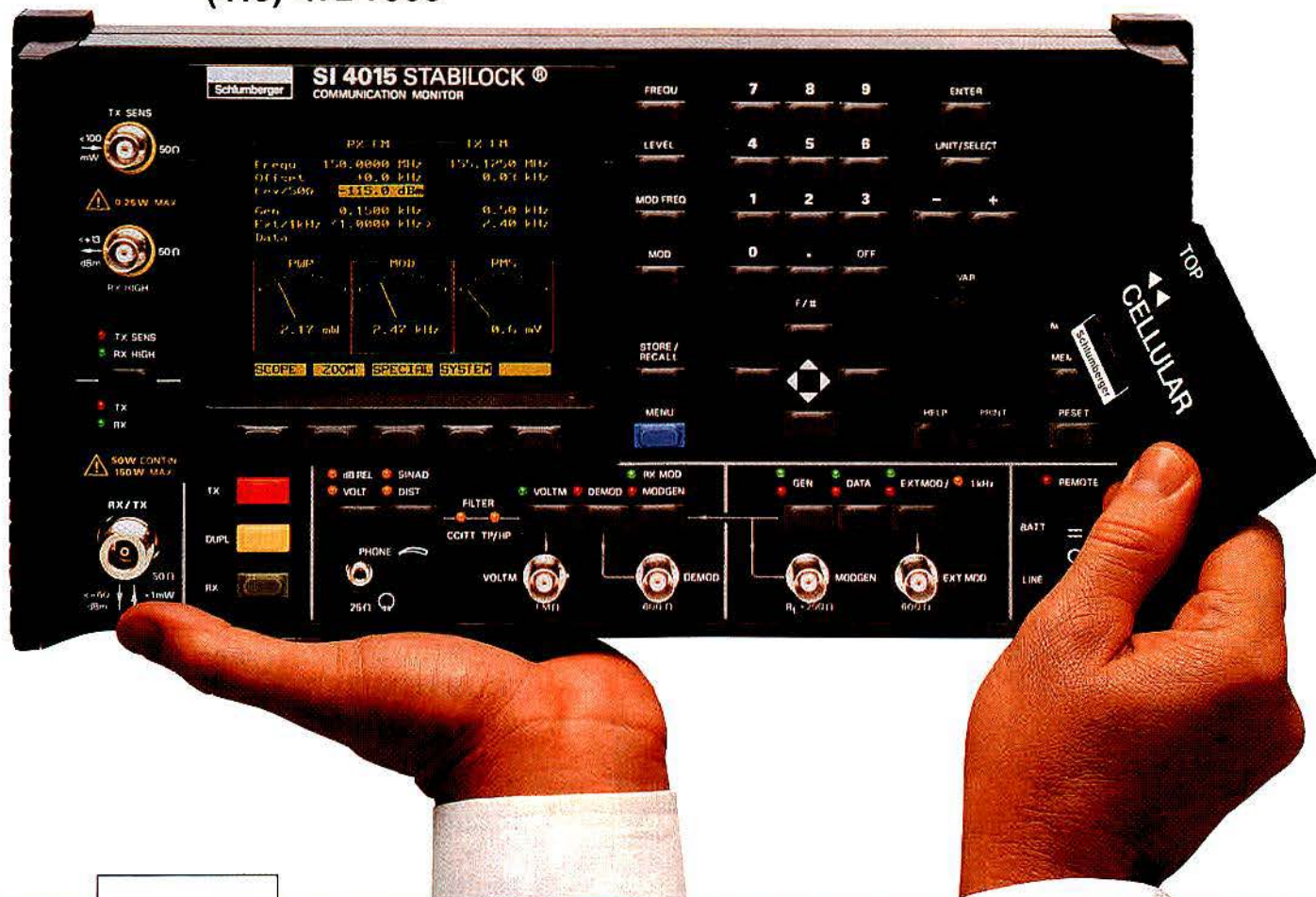
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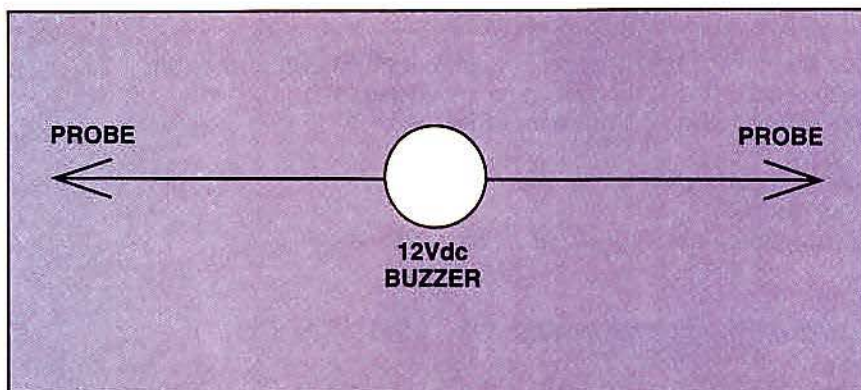


Figure 2. To verify whether the radio is receiving power when the vehicle engine has been started, connect a power finder (configured as shown) across the ground and power wires on the control head or the red wire on most front-mounted radios. When power is present, the power finder emits an audible tone.

If your test with the wattmeter shows no power output and no reflected power, check the radio's fuses. Many radios have two fuses, a large one for the transmitter and a smaller one for the remaining circuits. Some have two transmitter fuses and one other fuse.

Check to see that the ground wires are

tight. Usually a large black wire goes to the radio and a smaller black wire goes to the control head, if the radio has one.

Another possible reason for lack of power output is a broken wire (open circuit) in the antenna cable. Check the cable continuity using a tester such as the

one shown in Figure 1 on page 60.

#### Poor transmit

If the wattmeter shows about half the rated power output and half that power reflected back, check the antenna connector or mount for a short with the continuity tester.

If more than 10% of the power is reflected but more than 75% of the transmitter's rated power is measured by the wattmeter as forward power, check to see whether the antenna has been cut to the proper length and whether the antenna mount is dirty.

To troubleshoot the antenna length, put a 3-inch-to-6-inch piece of solder above the antenna tip by wrapping some of the solder around the tip to hold it in place. If the reflected power goes up or down, the antenna probably is cut to the wrong length. Refer to the antenna-cutting chart for the proper length. If the reflected power does not change with the solder extension, remove the solder, check and clean the antenna mount again, and re-test for reflected power.

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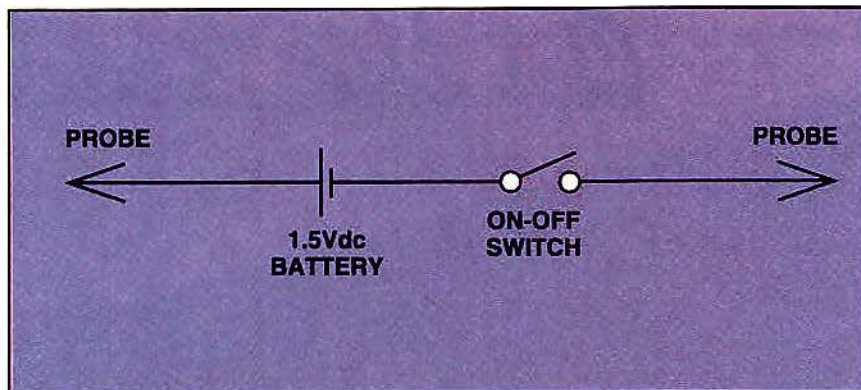


Figure 3. With the radio and vehicle engine switched off, verify that the external speaker is functional with a tester configured as shown. Switch the tester on and push the probe tips through the speaker wire insulation, one tip on each wire. If the speaker clicks each time you probe the wires, the speaker is functional.

If the problem persists, it is time to refer the matter to a technician.

#### Receiver

If there is no audio at the control head and no squelch noise, check to see whether the tone squelch is off or the

unit is in monitor mode (for noise). Make sure the microphone is off the hanger and not grounded.

Start the vehicle's engine. Some radios take their power from the ignition side of the switch. If there still is no audio (squelch noise), connect a power

finder (See Figure 2 on page 64) across ground and the power wire on the control head or the red wire on most front-mounted radios. When power is present, the power finder emits a tone.

Check all the power wires for tone. Then use the continuity tester to check ground contacts. There should be a tone when the tester is grounded to the chassis and the probe is applied to the ground wire. If the continuity tester emits a tone, check the radio speaker.

If the radio speaker is external, check it with a speaker tester such as the one shown in Figure 3 to the left. Turn off the radio and the vehicle engine. With the tester's switch turned on, push the probe tips through the speaker wire insulation, one tip on each wire. If the speaker clicks each time you probe the speaker wire, the speaker is functional.

If all these tests give positive results, the preliminary troubleshooting is complete, and it is time to take the radio into the service center so a technician can follow through.



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Circle (61) on Fast Fact Card



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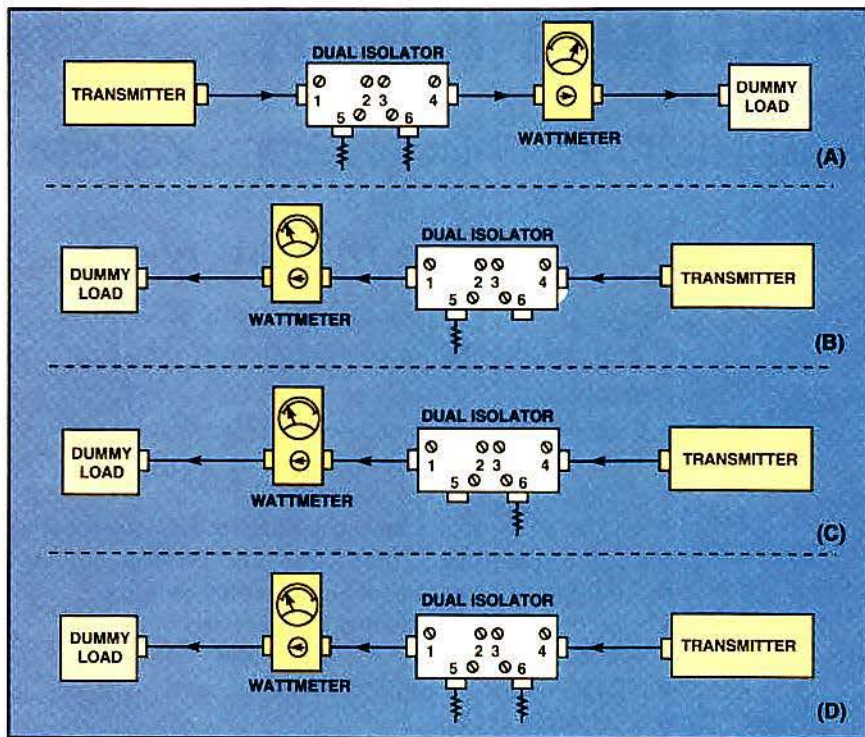


Figure 2. The first of three procedures for tuning dual-section isolators described in the text uses equipment configurations shown above.

(continued from page 8)

the tuning procedure.

**Procedure 2:** In this setup, a signal generator (highly stable) and a spectrum analyzer are used in place of the transmitter and wattmeter as the signal source and measurement instruments.

The signal generator frequency is set to the frequency to which the isolator is to be tuned. The spectrum analyzer is tuned to the same frequency.

If the spectrum analyzer is part of a service monitor, the frequency can be monitored on the frequency readout to keep the signal generator on frequency. If the signal generator is synthesized, you will not have to worry about frequency drift. Refer to Figure 3 on page 70 for this procedure.

(1) At Figure 3A, trimmers 1, 2, 3 & 4 are tuned for maximum indication on the spectrum analyzer display.

(2) At Figure 3B, trimmer 1 is adjusted for minimum indication on the spectrum analyzer display.

(3) At Figure 3C, trimmer 5 is ad-

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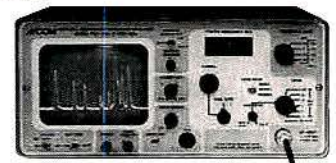
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## Technically speaking

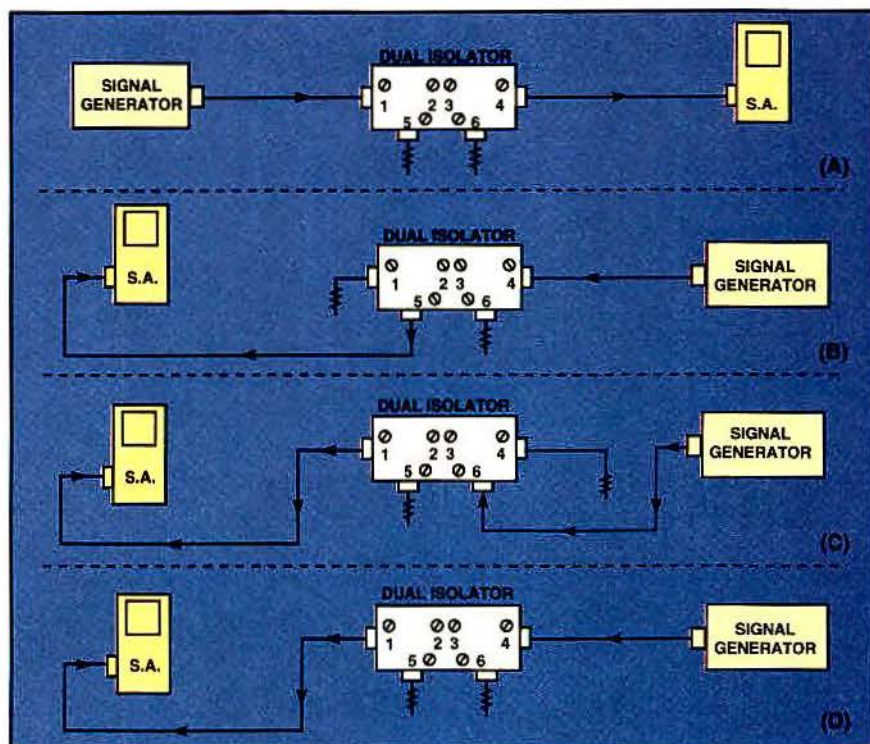


Figure 3. The second of three procedures for tuning dual-section isolators described in the text uses equipment configurations shown above.

justed for minimum indication on the spectrum analyzer display.

At Figure 3D, trimmers 5 and 6 are adjusted for minimum signal level on the display.

**Procedure 3:** The equipment required are a return loss bridge and spectrum analyzer-tracking generator combination. Refer to Figure 4 on page 72 for the following steps.

(1) At Figure 4A, trimmer 1 is adjusted for maximum return loss on the spectrum analyzer display.

(2) At Figure 4B, trimmer 4 is adjusted for maximum return loss on the spectrum analyzer display.

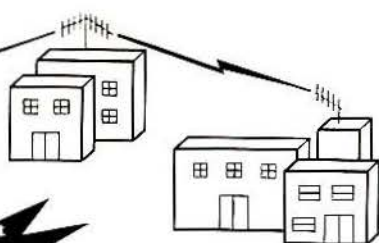
(3) At Figure 4C, trimmers 2 and 3 are adjusted for the best symmetry of the passband response of the isolator with the peak of the response curve at the desired center frequency.

(4) At Figure 4D, trimmer 5 is adjusted for minimum signal level on the display.

(5) At Figure 4E, trimmer 6 is adjusted for minimum signal level on the display.

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*Portable comes with: battery, antenna, wall charger and belt clip.  
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Synthesized, Field Programmable  
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30 Watts VHF 25 Watts UHF  
Frequency Bands: 136-174  
400-430, 450-512 MHz  
Wide Band Operation:  
VHF 15MHz/UHF 20 MHz  
Scan  
Tone Coded Squelch  
Digital Coded Squelch  
Two-Tone Sequential Decode  
Rugged, Uni-Body Housing  
Two Year Factory Warranty  
Made In USA

VHF \$469 UHF \$499

*Mobile comes with: installation kit, hand microphone  
and external speaker jack. Optional accessories: DTMF  
hand microphone and 5 watt external speaker.*

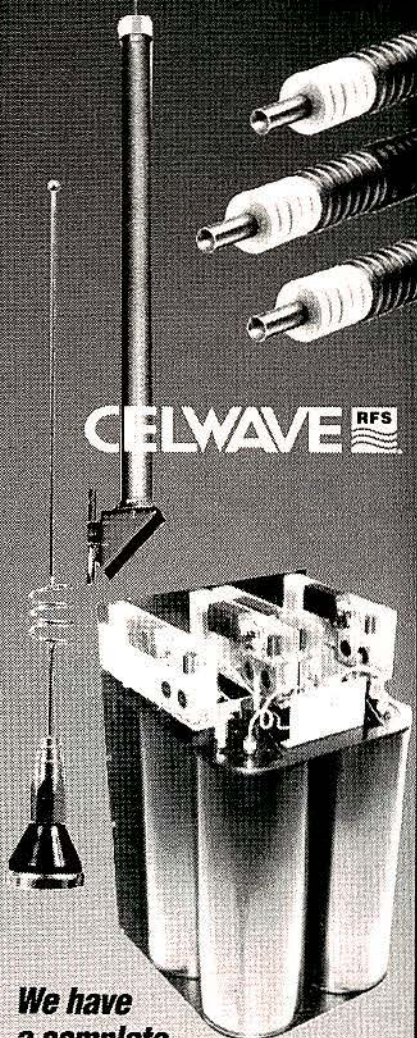
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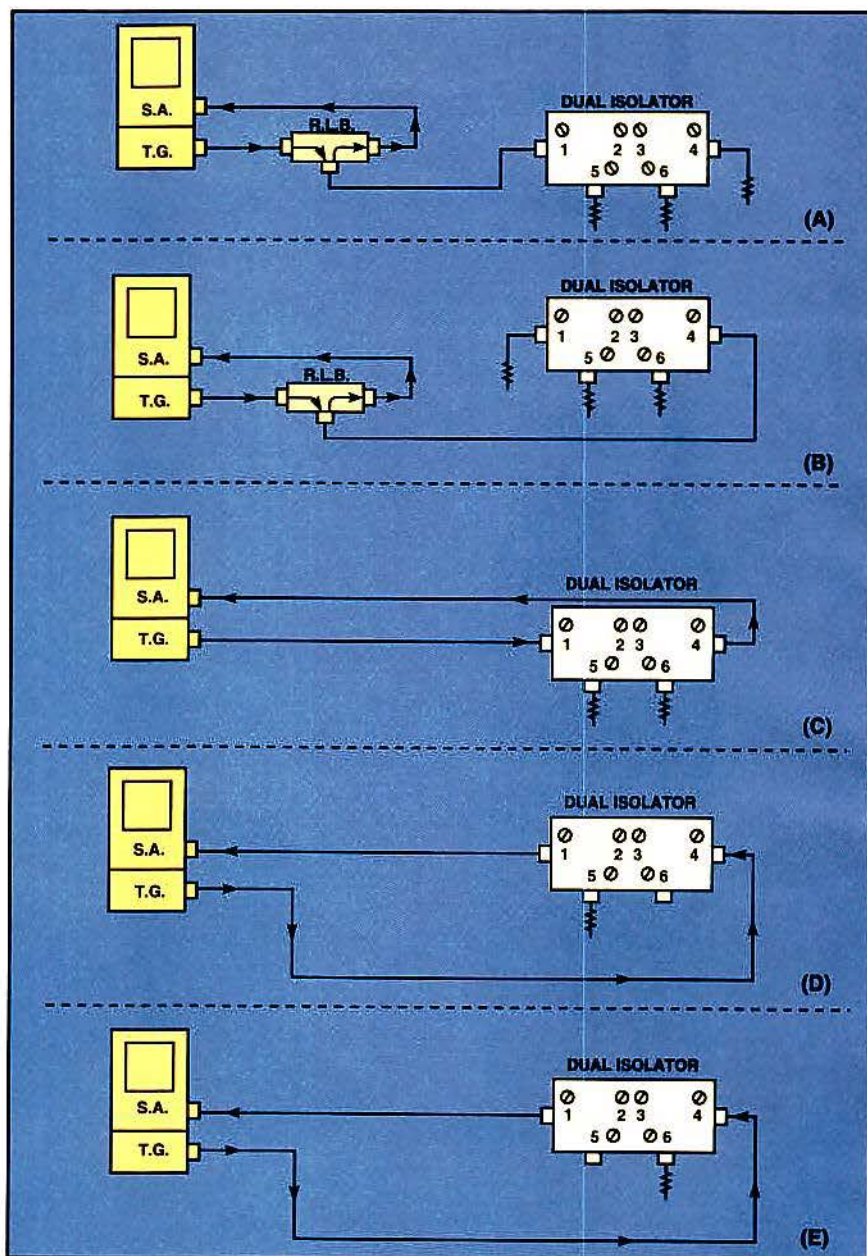


Figure 4. The third of three procedures for tuning dual-section isolators described in the text uses equipment configurations shown above.

Reconnect a load to port 5, and adjust trimmers 5 and 6 for minimum signal level on the display.

When tuning a dual isolator, never tune the load port trimmer with the associated load resistor removed. Remove one load at a time and adjust the opposite load port trimmer for maximum isolation (minimum signal level in the reverse direction).

After retuning an isolator, always check the insertion loss (forward direction) and isolation (reverse direction) and compare the results with the

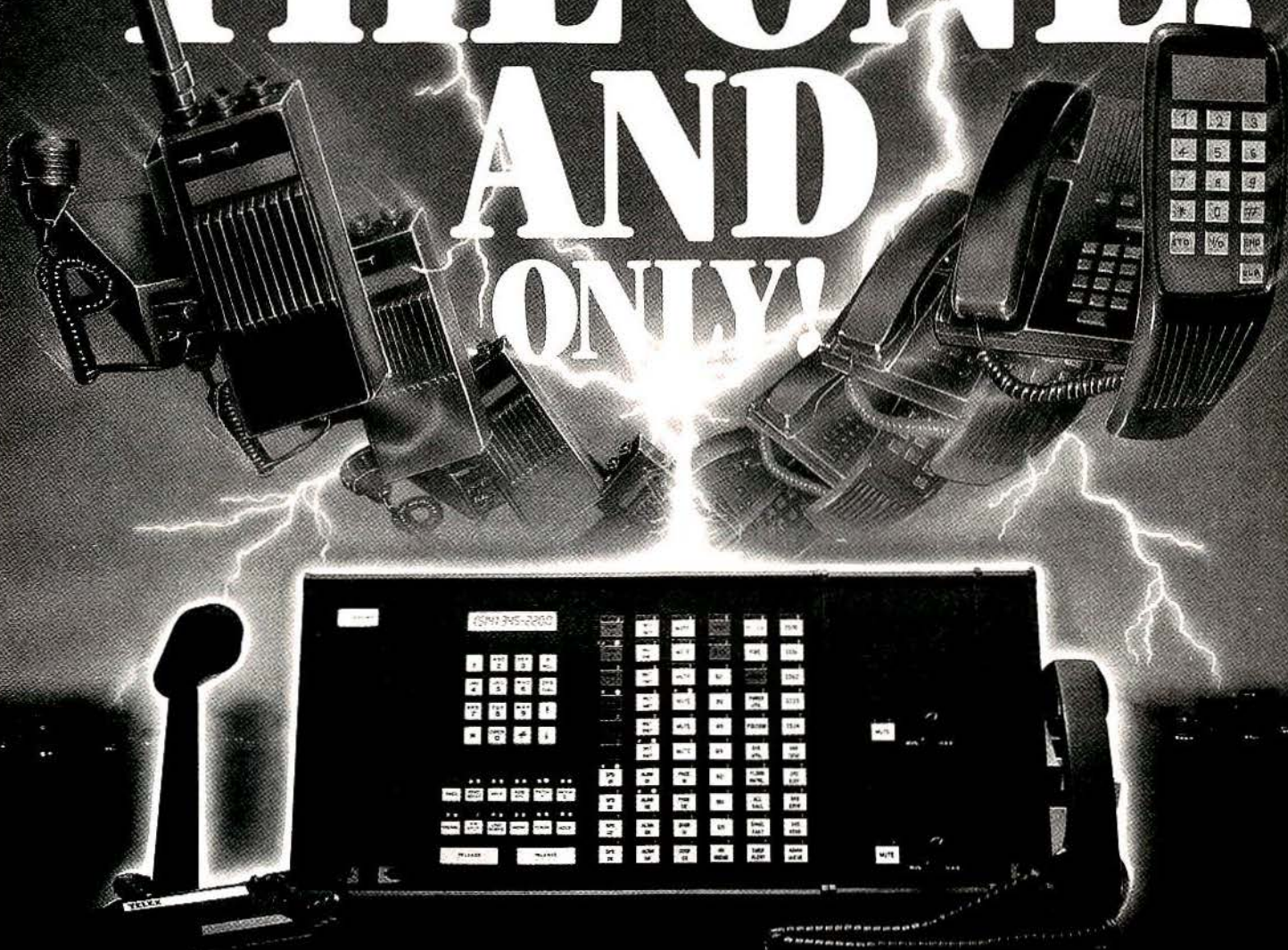
manufacturer's specifications. If the measurements do not meet the specification, retune the isolator. If the isolator still does not come up to specifications, consult the manufacturer.

As stated, these procedures are not all-inclusive. There are many other variations that are correct and proper that will get the job done.

The procedure that you use will depend on you and your particular arsenal of test equipment. Again, use common sense, and consult the manufacturer when you are in doubt.



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## Marketronics becomes AVL master dealer

Marketronics, Sunrise, FL, has been named by FacilTech Systems as a master dealer for its automatic vehicle location (AVL) products that use the global positioning system (GPS). GPS is a constellation of satellites that orbits the earth twice

a day, transmitting precise time and position information. In 1993, the system is expected to be 100% complete with 21 active satellites providing worldwide positioning data 24 hours a day.

## Decibel activates remote bulletin board

Decibel Products, Dallas, has activated a remote bulletin board free of charge for customers, communication system operators and RF engineers. The bulletin board can be accessed 24 hours a day by modem for product information, including digitized antenna patterns, application notes,

and trade show and seminar schedules. It offers "files" capability to allow downloading of data by users and on-line "help" and "tutor" for user assistance. The phone number is 214-819-4254; the modem format is 300/1200/2400/9600/14400 - N81.

## TekNow, Motorola announce wireless data messaging system

The PhenX Link send and receive system from TekNow and Motorola allows sending any computer data from a standard PC with a modem to any receiving computer equipped with a radio receiver. The PhenX Link system supports Motorola's NewsStream Advanced Information receiver's ability to receive either alpha text messages using the standard Telocator alphanumeric protocol (TAP) or

data messages using the Telocator data protocol (TDP) suite of protocols. The sender specifies the recipient's name, types a message (if desired) and enters the name of any file to be attached. This information, which could be a fax, graphics, spreadsheet, E-mail or a contract prepared by a word processing program, then can be sent to a mobile individual.

## RTX moves to larger headquarters

RTX, a Melbourne, FL-based radio-telephone exchange manufacturer, has moved into larger headquarters. The company can be reached at 4343 Fortune Place, Melbourne, FL 32904; 800-848-4789.

## Subscriber Computing moves to larger facilities

Subscriber Computing (SCI) has expanded to larger corporate offices. The company can be reached at 23161 Mill Creek Drive, Suite 200, Laguna Hills, CA 92653-1649; phone 714-588-3700; fax 714-837-0987.

## JBro wins excellence award

JBro, Lisle, IL, has won The Circle of Excellence Award for outstanding NiCd battery sales achievement from Gates Energy Products. The award recognized outstanding performance by Gates Energy Products' value-added centers (VACs) for assembling and distributing the company's product lines of sealed-lead, nickel hydride and NiCd rechargeable batteries.

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## News

### Hughes chairman to speak at Radio Club of America dinner, presentation

Jack A. Shaw, chairman of Hughes Network Systems, will be the keynote speaker at the 84th Annual Dinner and Awards Presentation of the Radio Club of America to be held at the New York Athletic Club in New York City on Nov. 19, 1993. Six awards will be given out this year, including: The Sarnoff Citation, The Ralph Batcher Memorial Award, The Jack

Popple Broadcast Award, The Fred M. Link Award, The Allen B. Dumont Citation and the Special Services Award. Twenty-five members of the club will also be elevated to the membership grade of Fellow during the presentation. For reservations, contact Connie Conte, c/o Tele-Measurements, 145 Main Ave., Clifton, NJ 07014-7018.

### Mobile Mark machining technician represents United States in international competition

When the 32nd annual International Youth Skill Olympics (IYSO) are held in Taipei, Taiwan, July 22-Aug. 3, participants from around the world will be representing their respective countries to determine who are the best young practitioners of more than 30 vocational skills. One of the participants will be Jerry Hodyl, an apprentice precision machinist from Mobile Mark Communications Antennas, Schiller Park, IL.

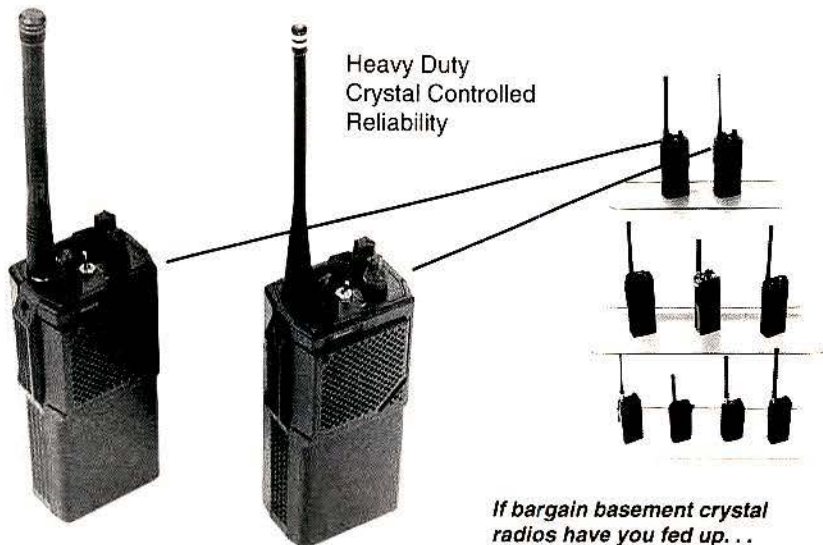
Hodyl's specialty is milling, and he has an impressive record in previous competitions—three overall First Place finishes at

the state level, high scores in milling at the national level and First Place in milling at the International Machine Tool Show Machine Trials in 1992.

At Mobile Mark, which is sponsoring his apprenticeship, Hodyl is primarily responsible for building prototypes of new products, although he is sometimes given the opportunity to design and build entire machines to facilitate the production process. "This is a great job," said Hodyl. "I get to make things that have never been made before. It's not the same thing over and over again."



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### Synthesized Wideband Mobile Radios



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### Synthesized Wideband Mobile Radios

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FTL-2011 VHF:

134-174 MHz, 40 Watt

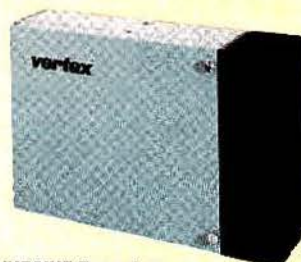
FTL-7011 UHF:

400-512 MHz, 25 Watt



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